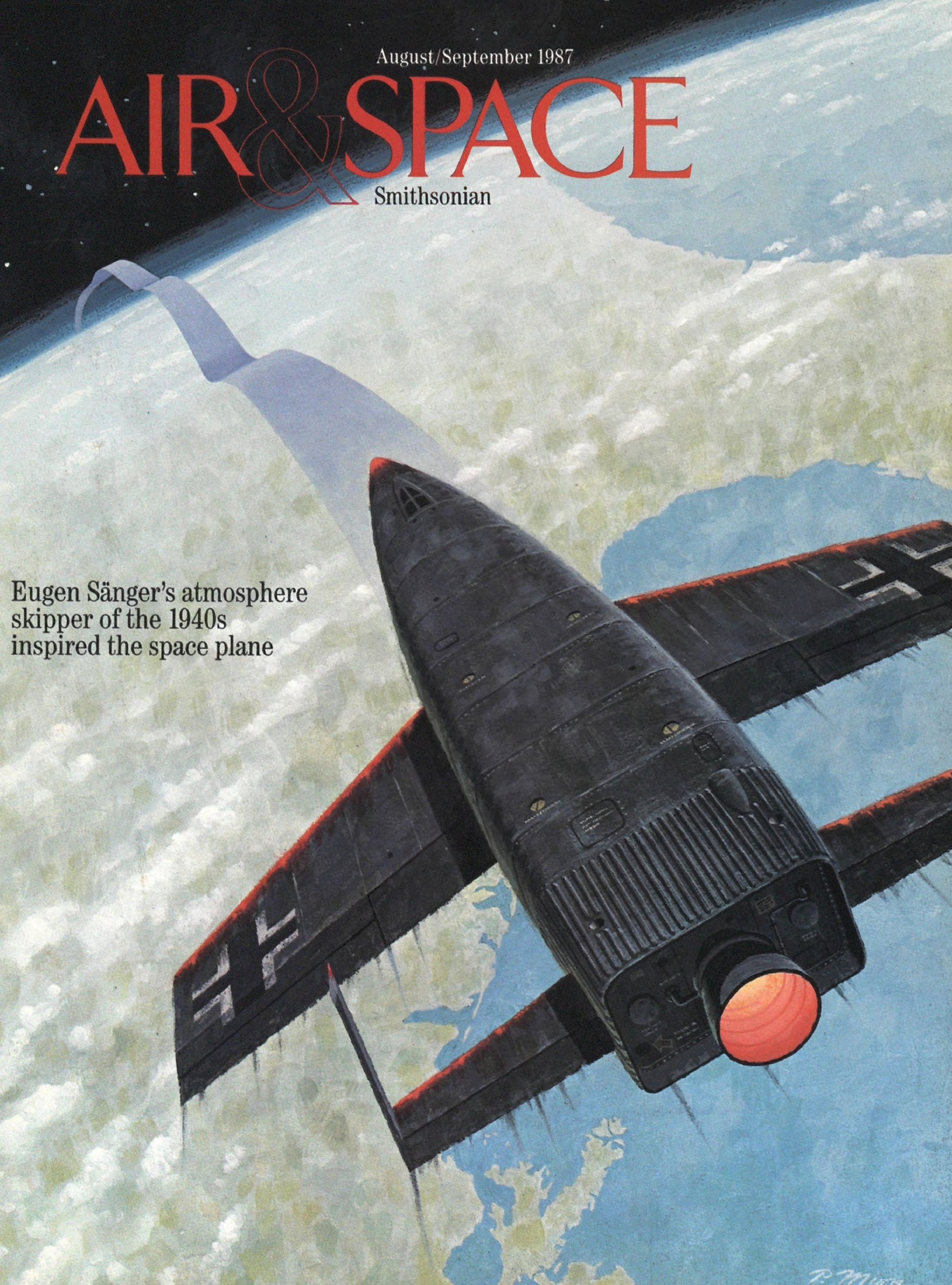


August/September 1987

AIR & SPACE

Smithsonian

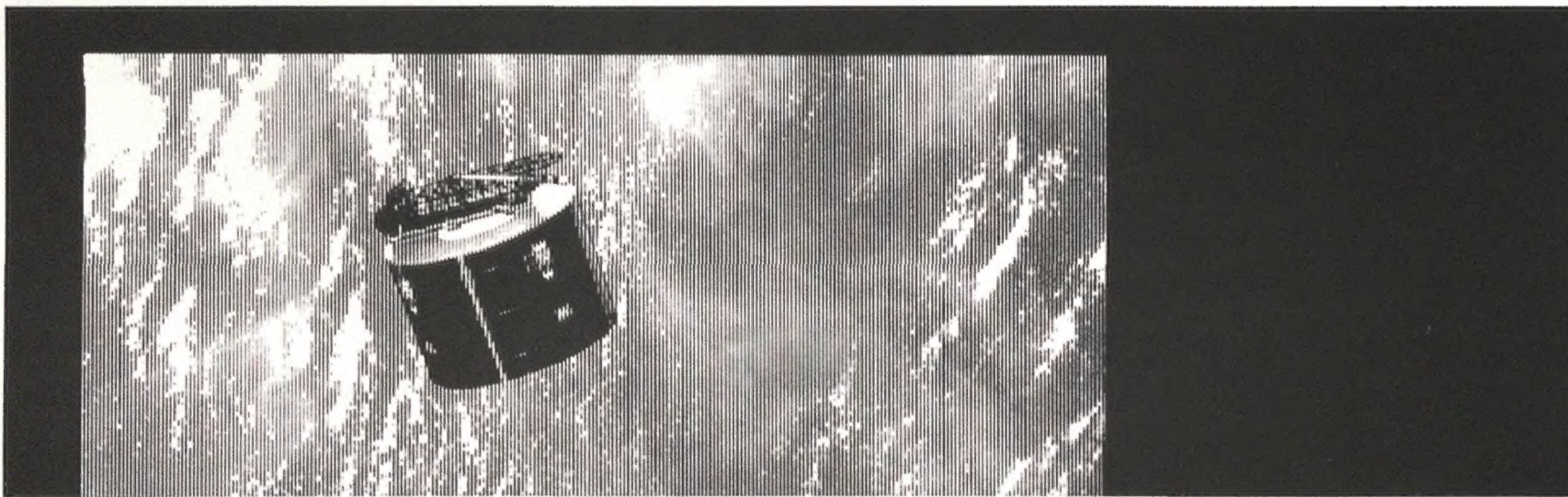
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skipper of the 1940s
inspired the space plane



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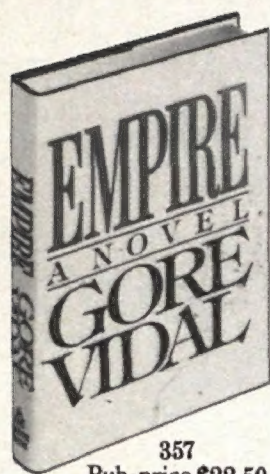


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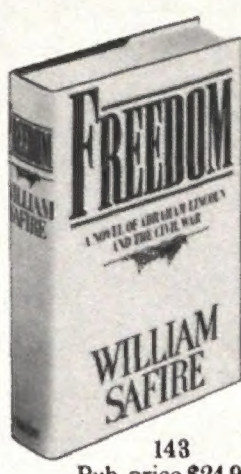
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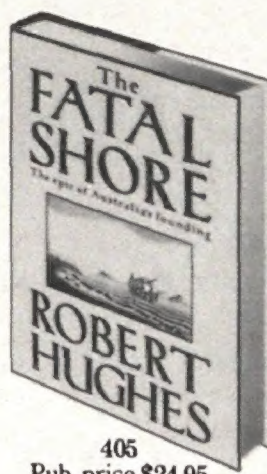
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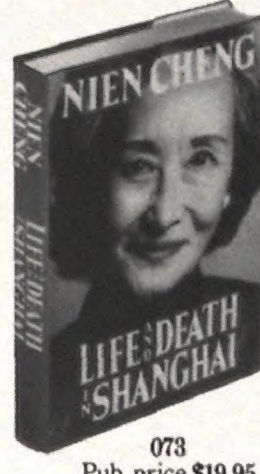
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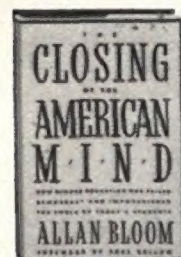
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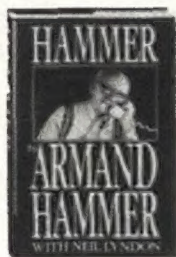
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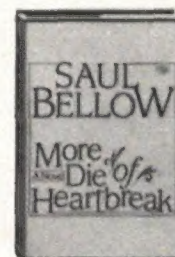
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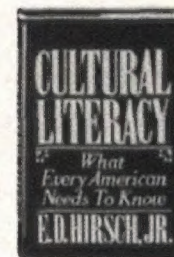
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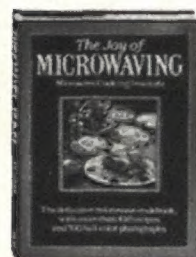
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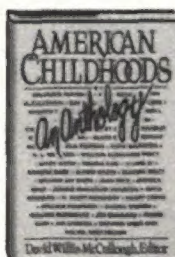
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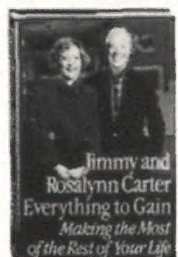
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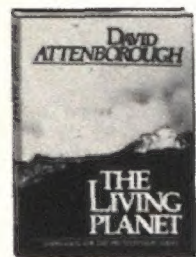
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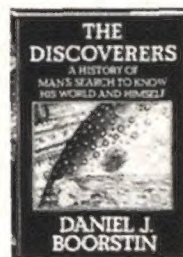
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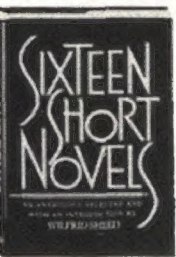
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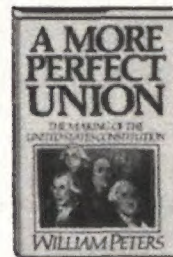
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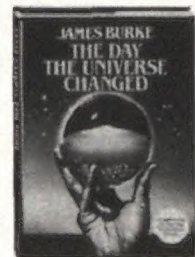
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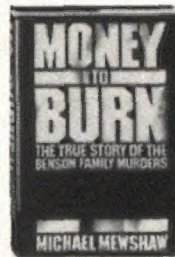
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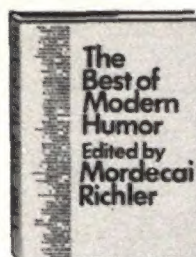
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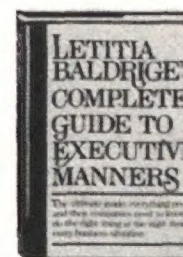
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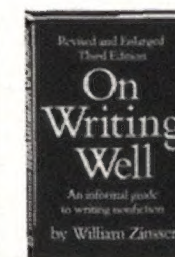
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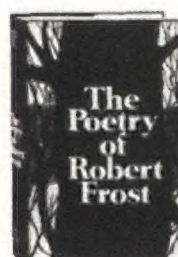
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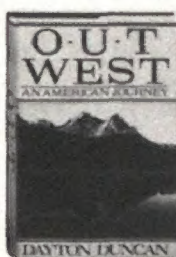
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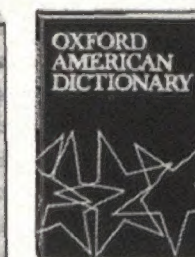
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The Wrights knew what they were doing—maybe that's why they were able to do it so cheaply.



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These folks bring new meaning to the phrase "getting away from it all," and when they go on their dream vacation they'll leave the usual paraphernalia behind. Sunscreen, bathing suits, and beach umbrellas won't be very useful in Earth orbit.



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Jonathan Swift published Gulliver's Travels in 1726. If the whole book were as accurate as Swift's musings about the Martian moons, we'd have to keep a sharp lookout for Lilliputians.



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If this pigeon comes in first in a race against dozens of others, this guy wins a bundle. Easy money. Unless you're the pigeon.



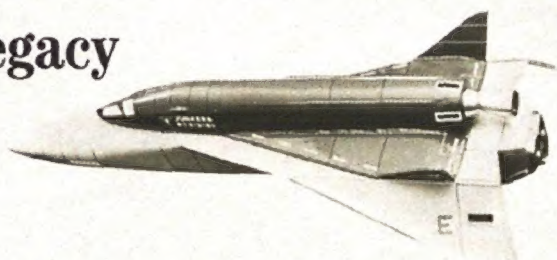
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Heartbeat

It's not as if we awakened one morning to find that overnight, computers had taken over aerospace. The revolution has been going on for years, and today, the pulse of the computer is the heartbeat of aerospace. But when revolutions are gradual, recognition of what they've accomplished sometimes lags.

The Museum has been aware of the computer revolution for some time and has been studying ways to acknowledge and reflect it. At first we thought it would suffice to devote one corner of the Flight Technology Gallery to aerospace computers. But it soon became apparent that the computer's influence on aerospace was so profound and diverse that we had to devote an entire gallery to it.

In May 1989, a gallery dedicated to computers in aerospace will open its doors. Our plans for its displays embrace such a wide variety of aerospace activities that even we are a little surprised at the scope.

Perhaps the most dramatic—certainly the largest—artifact in the gallery will be a mockup of the Grumman X-29. This experimental airplane cannot be flown without its flight control system, which is a special-purpose computer. The X-29 represents one of the most advanced applications of electronic stability techniques currently used in a research aircraft.

A Link trainer and a space shuttle simulator will demonstrate flight simulation, perhaps the activity that has benefited most from the power of the computer. Simulators have become so realistic that they mimic every detail of the aircraft and flight conditions for which they are programmed. A pilot can be trained so thoroughly by computerized simulation that his first flight in a real airplane is the one in which he takes his flight test.

The role of large computers in aerospace design and engineering will be exemplified by a Cray supercomputer. The Cray and its generation of ultrafast processors have made possible the digital modeling of systems as complex as the flow of air through a wind tunnel. And as a reminder of the way things used to be, a slide rule—

now an antique—will be on display nearby.

The *Mariner 10* will serve as a reminder of the key role of computers in guiding precise space maneuvers, such as the one that allowed the spacecraft to use the mass of Venus as a slingshot to propel itself on to Mercury. The margin for error in such a maneuver is so tight that the attempt can only be made with a computer to handle the number crunching.

Computer-aided design and manufacturing will be well dramatized with demonstrations of software currently in use. What the visitors won't see are the vast rooms filled with blueprints—the old way of doing things—that have been completely supplanted by images stored in computer memory and accessible at the touch of a key.

We've been guided throughout the planning of this gallery by the desire to show what computers do, to instill a sense that they are tools. The computer is not an end but a means, and the exhibit will reflect that by portraying the work computers perform, not just the computers themselves.

We also want the exhibits to be highly interactive, so that visitors can experience the computer's astonishing power directly. Now in the design stage is a simulation of a P-51 Mustang flight on a personal computer. Visitors will be able to gain first-hand a sense of how the fighter responds to simple control movements.

In every case, the computer applications we've selected present the expansion of established, fundamental aeronautic and astronautic principles.

From the beginning, the aerospace community has had a strong influence on computer design. Aerospace computers have to work with absolute reliability. They have to be light, small, and user-friendly. And one impression visitors will leave this gallery with is that while computers have been good for aerospace, aerospace has been good for computers, too.

—Paul E. Ceruzzi, Associate Curator,
Department of Space Science and
Exploration

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And note this: the full-length inside storm flap of our jacket is tucked *beneath* the smooth-running zipper . . . to keep the wind from whistling between the teeth of the zipper as it can on ordinary jackets. The Squall has fully-lined sleeves, zippered hand-warmer cargo pockets, a high collar that protects neck and chin, a zippered inside pocket for your keys and I.D., even warm Thinsulate® insulation in the sleeves for protection against wintry waters. All this, and it's machine washable.

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Letters

Back-seat Flying

As one of those kids who used to bicycle out to the airport and run errands in exchange for airplane rides, I can empathize completely with Jack Doub and his experience ("The Little Yellow Airplane," June/July 1987). However, his article needs one minor correction.

There are no rear-seat instruments in a Cub. All the instruments are on a single panel ahead of the front seat and the pilot, who always flies from the back seat and reads them over or around the shoulders of the front-seat occupant.

Peter M. Bowers
Seattle, Washington

Model Memories

I have been a model builder for over 12 years now, and could relate very well to the colorful descriptions of the building of balsa models ("Rhapsody in Glue," June/July 1987). The author was right on target.

However, I didn't appreciate the negative comments on plastic kits. Most kits today are designed for adults. I have kits with all of the hydraulic tubing installed, seat belts with accurate buckles, rudder cables, and electric lighting. Mr. Pinkwater states that painting was the only major part of plastic kits. He obviously hasn't built one. It usually takes about a month for a good model builder to build a plastic kit, and painting is only about 10 percent of it.

Balsa kits are still alive and well, but plastic kits have just as much to offer.

Thomas T. Kipp
Bexley, Ohio

"Rhapsody in Glue" brings back many fond memories.

I spent many hours building the "stick" models and remember the pride when I presented the final creation to my parents. I also recall the frustration of trying to figure out how to hold everything down with all those straight pins. No one showed

us how to do it; we learned. One thing not mentioned was the nightly ritual of peeling the hardened Testor's glue off your fingers. That was amazing stuff.

The hours spent building those models, deciphering those cryptic instructions, and learning to solve the problems which the directions never seemed to address did seem to help prepare me for the computer age. I am just as fascinated with my computer today as I was with my Fokker Triplane (which I did build and hang from my bedroom ceiling). And I still look up when I hear the sound of an engine overhead.

Richard V. Musto
Port Jefferson, New York

Close Resemblance

I believe the airplane Howard Hughes used for his record round-the-world flight in 1938 was a Lockheed Lodestar, not an Electra ("The Rise and Fall of Floyd Bennett Field," June/July 1987).

V.P. Fieg
Greensboro, North Carolina

Editor's reply: According to an internal Lockheed history, the airplane Hughes used in his 1938 round-the-world flight was a Lockheed 14 Super Electra. The airplane is remarkably similar to the Model 18 Lodestar, introduced in 1939. The Lodestar was developed by stretching the Model 14 fuselage about five feet.

In the Air and on the Greens

The short piece on Frye Boots brought back happy memories of yesteryear (Soundings, June/July 1987). I bought my first pair of "Fighter Boots" when I received my Navy Wings of Gold in 1943. All fighter pilots felt they were standard equipment and wouldn't think of being seen in any other shoe. It was a definite mark of a fighter pilot.

The best story I ever heard was about a fighter pilot who had spikes installed so he



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could wear them while playing golf.

William S. Carlson
Cumberland Foreside, Maine

So Where Is the Luggage?

The "Satellite Sky" insert in the April/May
1987 issue is very interesting and
educational. This is the first time I learned
that the objects in space are satellites and
not lost airline luggage.

Robert H. Levings
Chicago, Illinois

Corrections

In "Grounded" (June/July 1987), the

volume of the clean room in which
Lockheed stores the Hubble Space Telescope
was incorrectly given as 520 cubic feet. It is
actually 520,000 cubic feet.

"Canvas Wings" (June/July 1987) states
that William Phillips joined the Air Force
Art Academy and donated his works to the
Air Force Academy. The works were
actually painted under the auspices of the
Air Force Art Program and donated to the
Air Force Art Collection.

Air & Space/Smithsonian welcomes
correspondence. Letters must be signed
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Slow Dancing

The Air Force has never learned the friendly skies routine. The interior of the KC-135 was like the inside of a long pipe—gray, poorly lit, utilitarian, lined with the girders and rivets that held it together. A few passenger seats were installed up near the cockpit. You could talk over the engine noise, if you screamed.

We were waiting for our B-52. The boom operator paced, wearing a radio headset and trailing a long cord. When the bomber arrived, the operator would guide its pilot to our tanker to begin the refueling operation. We all wore shoulder bags with masks and small bottles of oxygen in case of decompression.

Beneath us were many, many gallons of jet fuel. The airplane can carry 190,000 pounds of it, a major told me. The thought of all that combustible liquid beneath the floor will definitely concentrate your mind if you have to land with hot brakes. I did it once in Thailand when we had bases there, and the Air Force met us with most of the world's fire trucks. The KC-135, of which the Strategic Air Command, the National Guard, and the Army Reserves have 641, is not a dangerous aircraft. It is nonetheless a winged gas tank.

I had sat in the cockpit for the takeoff, which proved more interesting than I had expected. The KC-135 is a heavy brute—maximum gross takeoff weight is about 300,000 pounds, although we were well below that for this practice flight—with four awful, smoky turbojets that are so noisy they are not allowed at civilian airports. Either the runway had slight swells in it or the weight of the tanker makes it indecisive when taking off—whatever the reason, the airplane lumbered along, runway whipping past faster and faster, until suddenly there was a slight roller coaster sensation . . . *uuuup* . . . *doowwnnn*. We sort of surfed into the air.

An hour or so into the flight the boom operator yelled, "Bomber's back there." He

and I walked back to the tail and climbed down into what looked like slit trenches. We lay on our stomachs and peered down through four miles of nothing to the desert of west Texas—drab browns gashed as if high winds had carved up the earth millions of years ago. In front of us, just under the window, was the boom-control panel. A cardboard sign taped to the console gave the call signs of the tanker ("Canis 09") and the bomber ("Rambo").

Miles behind us the bomber hung in space, a black dot against a tower of cloud. It grew slowly.

The boom-control panel has two sticks. One, held in the boomer's right hand, moves the boom up, down, left, and right. Actually the boom controls move small wings—"ruddervators"—on the end of the boom that fly it in the desired direction. The response was mushy and a bit delayed, but easy to get used to. The other stick extends and retracts the probe. It hisses when it moves. The panel also has knobs that set an automatic disconnect system so that if the receiving craft were to drift too far to one side, the boom would automatically let go. Although refueling is simple, large forces are involved and the bomber could easily tear the probe from the tanker.

Americans do a lot of air-to-air refueling and are good at it. Refueling is not an occasional trick or exotic technique but a mainstay of U.S. air power. The Soviets

employ it too, but not to the same degree. The U.S. Strategic Air Command bombers depend on it, of course, but so do fighter forces. In regions of the world where U.S. airplanes cannot depend on landing rights, the ability to meet a tanker from a distant base and get gas is vital.

The B-52 crept closer, an evil-looking thing. Some confused instinct deep in my mind urged, *Let's go faster. It's gaining*. But the bomber's approach was actually slower than necessary because this was a training flight. The Air Force doesn't say so, but good pilots can slap their craft on and off the boom much faster.

"Fighters are really fast," the sergeant told me. "Agile. They stay on the wing in formation and just twitch back onto the boom. It's pretty. We can get them on and off in three minutes, exclusive of pumping."

Like many things the military does, refueling is dangerous. The Air Force refueled 115,279 aircraft in 1986, there being only two ways to do dangerous things safely—don't do them at all, or do them all the time to stay in practice.

One hundred yards back the big green monster oozed closer, flying precisely now. The boom operator became more attentive. Below us Texas disappeared in piles of cloud. The intercom chatter acquired the highly focused casualness of military men who do not want to make a mistake. Refueling accidents are rare but serious.

USAF



A B-52 gulps fuel from the smaller KC-135 tanker, only 20 feet away.



George Hall

Small wings called "ruddervators" fly the boom into docking position.

Should anything go wrong, the boom operator would call, "Canis Nine, breakoff, breakoff, breakoff," whereupon the KC would climb at full throttle and the bomber would dive 1,000 feet. This works best if the bomber has not already rammed the tanker.

The bomber was 40 feet away and creeping. I could see odd little ripples in the metal skin of its wings. B-52s have wrinkles. The flight was a geriatric assignation, really. The B-52 first flew in 1954, and the last one came off the production lines in 1962. The KC-135 is another antique. The Air Force got its first one in 1957, and the production line was closed in 1965. The B-1B, now trickling into service, is a sleeker product. So is the KC-10 refueler, a modified DC-10, yet the

KC-135 is getting a new engine for use past the year 2000.

At least it's not a biplane.

At 20 feet, the bomber was *close*. I could see a hand through its canopy. A kid with a peashooter could have aimed at individual rivets. The cockpit windows were dark and sinister, like the eyes of a great evil wasp. The precision of this curious ballet was startling: flying at several hundred knots, the bomber was creeping up on us at less than a walking pace, and as accurately. The boom operator talked quietly into his microphone, guiding the beast in.

He can do it at night in radio silence, as was done in the Libyan raid, but the crews have to be very good. The tanker has small signal lights under the fuselage, worked by a toggle switch on the boom operator's panel to signal the pilot to creep forward or backward. Night refueling can get complicated: when the receiving aircraft are camouflaged, the boom operator's depth

perception often fails.

The bomber was so close I could see a wedding ring on the copilot's hand. The boomer flew the boom over the receptacle behind the cockpit and extended it. The long shiny pipe slid into the opening—*ssssss!*—and the locking mechanism took hold. If this were for real, the pilots in the KC's cockpit would have started the four pumps and monitored the flow. Instead we just flew smoothly for several minutes. It looked easy. Shortly we would see that it wasn't. The copilot of the B-52 was going to try his hand at connecting.

"You gotta watch copilots carefully," said the boomer. "They've got less experience. They have to learn somehow, but you gotta watch 'em." Like student brain surgeons.

Sure enough, the bomber edged forward awkwardly. First it came too fast and then cut back too much—not wild but definitely ragged. Finally we got the boom into him, but he kept swinging off to the right, close to the disconnect limits. He wasn't flying badly, but the guy was obviously still learning. At one point he surged up toward us and I found myself grabbing for a girder and bracing for the shock. It wasn't really that close, but someone said over the intercom, "Keep your heads up on this one."

Time and again the bomber fell back and came forward for the boom. Periodically, the boomer sent a few gallons through the boom to keep the mechanism lubricated. The fuel sprayed from the overflow tubes into the airstream. A couple of times the bomber went too far to the right and the boom disconnected. The fellow was getting better, although he never equalled the syrupy smoothness of the first pilot. He would have to learn more another day. It was almost time to go home.

We left the harsh, jagged desert and flew over a vast expanse of crenellated clouds, huge puffy towers rising almost to our altitude. Great cloud cliffs tumbled sharply, billow after billow, ledge after vast complicated ledge, down to cloud valleys. The slanted afternoon light left the deeper canyons dark and shadowy, the eastern scarps dirty yellow blending to luminous snow. Wisps of mist, unattached to the looming walls, glowed over the depths. Against the gleaming backdrop the bomber looked weird, alien.

"Pretty, isn't it?" said the boom operator. The bomber dropped away after a final approach and headed back to its base. Box lunches and coffee waited up front, but we lay for a few minutes watching the clouds. There are reasons for flying other than the pay.

—Fred Reed

Whistler's Brother

Navy pilots have to be sharp. After all, they land on boats. And now they have to remember that when the Whistler radar detectors in their cars beep, they hit the brakes; but when the Whistlers in their cockpits light up, they hit full afterburner.

Some F-14 Tomcats, A-7 Corsairs, and A-6 Intruders carry off-the-shelf civilian speed-radar receivers to detect missiles. In 1979 the Navy quietly bought 750 Q1000 receivers from Whistler, a Westford, Massachusetts company, and stuck them in the aircraft with Velcro. A defense department official interviewed in May by the *Washington Post* minimized the buy as "a stopgap measure," but Whistler says the Navy apparently liked the units so much that five years later, after the Q1000 had been discontinued, it scoured dealers' shelves all over the country to restock.

According to microwave-industry legend, the story began when a Navy pilot became frustrated flying his F-4 Phantom against a

new fighter under test. One day he rigged up a power supply and moved his car's detector to his cockpit. Once he knew when he was being tracked by his opponent, his mock-combat score markedly improved. The Navy was intrigued, especially after the fall of the Shah of Iran: radar-guided Hawk missiles that the United States had sold to the Shah were now in the hands of the Ayatollah, and U.S. receivers weren't keyed to their frequency. But the Whistler Q1000 was.

Whistler wasn't thrilled to be called to arms. "When you're making a thousand detectors a day, you can't spend time answering military-specification questions for an order of 750 units," says Jack Turner, vice president of engineering at Whistler. "They wanted us to ship the units in plain boxes rather than our usual four-color cartons. We said, 'No way.' They sent us two inches of paperwork. We sent it back. The president of the company told

them, 'We'll stencil NO STEP on the box, but that's as far as we'll go to make it a military product.' " Whistler ended up simply shipping the units at \$180 each.

The Navy reportedly spent another \$2,500 per unit modifying the detectors. "It was a pretty shrewd deal," says *Car and Driver* editor Don Sherman, who probably has more experience in evading radar than most Tomcat pilots. "Twenty-five hundred dollars for *anything* to do with military radar is practically free."

Whistler never advertised its military sales coup ("Nine out of 10 Naval aviators agree . . ."). "Given the world situation and knowing where these things might be used, we didn't feel it would benefit anyone to use this as a selling tool," says John Vechione, marketing vice president. "My guess," says Jack Turner, "is that our customers at that time—truck-stop distributors—couldn't have cared less."

—Stephan Wilkinson

Greg Harlin/Stansbury, Ronsaville, Wood Inc.



The Moon Madness Debate

Astrologers must have had a field day with the full moon that rose on January 4, 1912, for it was literally one in a thousand. A rare alignment had brought the satellite closer to Earth than it had been at any time in the two centuries before or after. If the moon has any effect on human behavior, this pass should have settled the issue.

But it was a pretty ordinary Thursday. In the *New York Times*, peace talks and subway construction dominated the news. Even unusually high tides caused no concern.

However, most people still cling to the notion that a full moon brings out the worst in us. Legends concerning werewolves and lunacy abound, and over the years researchers have tried to link the phases of the moon with birthrates, epilepsy, arson, murder—even violence at hockey games.

The most publicized case for a cause-effect relationship was proffered in the 1970s by Arnold Lieber, a psychiatrist who heads the mood disorders unit at St. Francis Hospital in Miami. Lieber held that the full and new moons should cause emotional crests akin to high ocean tides. He and colleague Carolyn Sherin searched for a pattern among several thousand homicides committed in Miami and Cleveland over many years.

They found small peaks in the murder rate in both localities near the times of full and new moons. Lieber expanded on his belief in his 1978 book *The Lunar Effect*: "It is a killer Moon for individuals who are not physically balanced, or for a society too rigid to roll with the cosmic punch." He predicted that "gravo-receptors" that respond to the moon's pull would be discovered within the body.

Scientists attacked the Lieber-Sherin studies, claiming that unorthodox tests for statistical significance had been used. Those who tried to duplicate the analysis found no relationship.

Astronomers have been particularly critical of the whole idea. The moon's pull does not peak at new or full phase, but rather when the moon reaches perigee, its closest orbital point to Earth. Besides, whatever influence the moon might exert is miniscule compared to Earthly events. For example, the gravitational interaction between two people shaking hands is millions of times greater than the moon's attraction, even at its strongest. "I do not regard *The Lunar Effect* as pseudoscience in the usual sense," wrote University of California astronomer George Abell, referring to the realms of clairvoyancy, astrology, and related fields. "But it is certainly very bad science."



Although Lieber has withdrawn from the debate, he still maintains that there is an effect, if only a subtle one. "It's not solely a lunar effect, perhaps, but the interaction of a number of cosmic events that seems to set things off," he says.

Most scientists remain unconvinced. "Now we're not even looking at whether people are affected by lunar phases," says Florida International University psychologist James Rotton, "because it's clear they're not. What's under study is why we *think* people behave strangely during full moons."

—J. Kelly Beatty

Reading the Fine Print

When the nation celebrates the bicentennial of the Constitution this September, the document will be under review not only for its content but for its condition as well. Thanks to a National Aeronautics and Space Administration spin-off program that makes space technology available to outside users, the Constitution, Bill of Rights, and Declaration of Independence could have longer shelf lives.

Five years ago Congress asked the National Archives to assess the condition of these historic documents. Conservators suggested finding a way to gauge their condition without removing them from the helium-filled glass cases (the inert gas supports no life-forms) in which they have been stored since 1952. After someone mentioned NASA's *Spinoff* magazine as a possible source of techniques, Archives preservation officer Alan Calmes turned to NASA for help.

The agency referred him to the Jet Propulsion Laboratory in Pasadena, California. JPL, with decades of experience in developing sensors for planetary explorers, spent two years designing a monitoring system and hired the Perkin-Elmer Corporation of Hubble space telescope fame to build it.

Last February the \$3 million Charters Monitoring System took up residence—two rooms' worth—in the Archives. Its core is a photometer—an electronic camera of sorts—that converts light into digital data, which in turn are converted by computer into greatly enlarged images.

The system's imaging device, which is five to ten times as sensitive as the human eye, is mounted over a large laboratory table on nitrogen-filled legs that absorb vibration. Spacecraft sensors commonly record planetary features from thousands or even millions of miles away, but because

Déjà View

Now that all the Comet Halley hoopla has come and gone, the European Space Agency is setting its sights and its hardware on a 1992 visit by Comet Grigg-Skjellerup.

The *Giotto* comet probe eyeballed Halley from 300 miles in 1986 and gave scientists a stunning look at our best-known comet. Now ESA is mulling over another mission for the spacecraft. If funds are appropriated—and if *Giotto*'s camera is still functioning when it passes within 12,400 miles of its home

planet in 1990—ESA will send the spacecraft after Grigg-Skjellerup, or GS, as astronomers have nicknamed it.

Viewers who were disappointed by Halley's appearance, or lack thereof, are warned not to count on Grigg-Skjellerup, whose nucleus is less active than Halley's. "To find GS, you'd have to be in the southwestern desert with an eight-inch telescope," says Geoff Chester of the National Air and Space Museum planetarium. If ESA approves the mission, comet watchers can rely on *Giotto* for an up-close-and-personal report.

—Linda Billings

the imaging device used in the Archives system views its target from a few inches above the protective glass, it can detect features as small as a few hundred-thousandths of an inch. JPL engineer Edward Miller says the lab settled on an image size of one square inch. Magnified to fill a TV-size computer screen, it's the ideal size for studying subtle damage such as fading or flaking ink or any increase in microscopic tears.

Calmes says the Archives will begin with the Constitution and move on to the other charter documents, removing pages from public display one at a time until sections from all seven pages have been recorded for analysis. The imaging process is brief—it's the analysis that takes time—so visitors to the Archives will not find the document cases empty. The aim is to record the condition of the Archives' most valuable documents, and check them every few years for further deterioration. The collection of 18th century documents seems to be in fine shape, although the Declaration suffered some wear as it was carted from city to city during the Revolutionary War. It's the condition of World War II documents, printed on less durable paper, that worries curators.

—Linda Billings

Lightning Strikes

It could have been a scene from any World War II movie: a room full of fighter jocks, some in leather jackets, trading combat tales and buying one another drinks. But they weren't actors. They were the genuine article, P-38 pilots reunited in a Los Angeles hotel more than 40 years after their last missions and 50 years after Lockheed got the nod to start cranking out the remarkable Lightning twin-engine fighter.

In their youth, these knights had worn the king's best armor. Some who came

home in 1945 stayed in aviation. Others went into real estate and sporting goods. Now they had come from all over the country to a hotel near a factory where the armor had been assembled. They lingered at the bar, listened to the music of Glenn Miller, watched World War II slide shows and Lockheed training films, and talked about their common bond, one of the most rugged and versatile aircraft of World War II.

The Lightning flew all sorts of missions equally well: night combat, reconnaissance, low-level attack, high-altitude bombing runs, ambulance flights, cargo transport, and more. In the heat of battle, its two engines proved more than just sound engineering: because the cockpit sat between them, the pilot was somewhat protected from enemy fire. Pilots said the tricycle gear made landings a piece of cake, and on takeoff, the counter-rotating propellers dispensed with the torque problems of single-engine airplanes.

But the P-38 wasn't all sweetness and light. Early models gave the line a bad reputation: compressibility, due to the onset of supersonic shock, caused turbulent airflow over the wings and made it virtually impossible to control the craft in a high-speed dive. The Allison engines quit from time to time, and losing one on takeoff was every Lightning pilot's greatest fear.

Losing one at altitude, however, caused far less panic.

"I lost an engine over Bulgaria," said retired United Airlines pilot Jack Wagner. "But the other took me 450 miles to Italy. And the P-38s were fast and comfortable—like Cadillacs."

"I lost 14 engines altogether," said retired Lockheed test pilot Tony LeVier, who toured Army Air Corps bases in England, demonstrating how to handle a twin-engine fighter. "But even on one engine you could bring it home at better than 200 mph."

The years had been kind to the white-crested birdmen. Their midsections had thickened, but they still loved to dance to big-band music. Their combat stories were interwoven with talk of children and grandchildren. At Chino airport, they patiently waited in line to sit in a pampered Lightning flown in from Texas, one of only 11 remaining of the nearly 10,000 built. It was the most expensive fighter of World War II, and its maintenance costs skyrocketed over the years. Nonetheless, the "fork-tailed devil," as the Luftwaffe called it, was a legend in its own time. "It was definitely the glamour plane," said Joe Kuhn, now a Lockheed executive. "Everyone wanted to fly the -38. Some of us actually got to."

—Mike Blakemore

Playing the Straight Man at Cessna

The phones in the public relations department at Cessna Aircraft were ringing off the hook for days after West German pilot Mathias Rust dropped in on Moscow's Red Square in a Cessna 172 last May. Dean Humphrey, veteran Cessna PR man, fielded calls from the media deftly. "They're all titillated over this, asking if we're now producing light stealth aircraft and pumping me for one-liners," Humphrey said. "Unfortunately, all I can give them is statistics: how many we've sold, how fast and how far they go. Basically, the airplane

did exactly what it was designed to do.

Where it does this is up to the pilot—and of no concern to Cessna."

Callers suggested that Cessna mount a new ad campaign targeted at Soviet citizens, focusing on long-distance flight and precision-landing capabilities. "It would be easier to get caught up in the fun of this if the airplane were still in production," Humphrey said. Nevertheless, the joyride gave company spirit—and publicity—a much-needed boost.

—Patricia Trenner



Greg Harlin/SRW Inc.



Multilayer ceramic wiring boards can be built at lower cost with a new process for applying dielectric layers during fabrication. The new technique, developed by Hughes Aircraft Company, is called TTRAN™ and is both faster and more reliable than conventional thick-film technology. Instead of screen-printing the dielectric, the process presses and heat-seals it from a tape to any size substrate. This makes fabrication easier and reduces both labor and processing time. Applications include computers, missiles, and radar systems, where high reliability and resistance to harsh environments are vital.

Upgraded flight simulators will depict mission imagery realistically for U.S. Navy F/A-18 pilots. Hughes is modifying its Weapons Tactics Trainers (WTT) to project high-resolution, full color, real-time simulated images of terrain features and man-made structures on 360-degree field-of-view dome screens that surround the trainer's cockpit. The out-the-window scenes will be produced by advanced computer imaging technology, using a digital database that represents 70,000 square miles of western Arizona and southern California terrain. The new simulated visual system will allow pilots to safely practice a host of complex combat scenarios without expending fuel or weapons.

U.S. Army's Fiber Optic Guided Missile (FOG-M) uses a new winding technology to deploy its plastic-coated glass fiber. This fiber permits a two-way jam-proof communication link for transmission of television-like pictures of enemy armor and helicopters to a gunner station located in a protected position. Using technologies learned from 20 years of producing Tube-launched, Optically tracked, Wire-guided (TOW) missiles, Hughes engineers developed a method of precisely winding optical strands so that they can be dispensed at missile velocities without interruption of the data transmission. Because the optical fibers are not much larger than the thickness of a strand of human hair and are elastic and pliable, Hughes invented a device which precisely measures the elasticity of each fiber thus allowing it to be spool-wound with precision. Another Hughes technological advancement is a diagnostic instrument that detects defects in the fiber.

The HR-3000, a new generation version of the Hughes Air Defense Radar (HADR), can detect and precisely locate fighter-sized aircraft more than 470 kilometers away. The phased array radar is designed for air traffic control in peacetime and can automatically detect wartime threats that appear simultaneously from several directions, even in the presence of heavy environmental clutter and severe electronic interference. The HR-3000 system is in full production at Hughes and will be used in Portugal and integrated with Hughes-built NATO Air Defense Ground Environment (NADGE) in Italy, Greece, and Turkey.

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I Left My in San Francisco

The Porsche engines mutter down to a whisper, and the blimp seems to plummet nose-first toward the ground. Looking over the pilot's shoulder I can see the landing site and the men in bright blue jumpsuits waiting to catch us like an ungainly beach ball. But when we are close enough to see their faces, we lumber to the right, then to the left. The blue suits run toward us, and I can't tell if I should be alarmed yet. I'm more concerned about what I had for lunch; I don't want to see it again.

On May 6, 1987, the 50th anniversary of the Hindenburg disaster, Airship Industries introduced blimp rides at Oakland Airport in Northern California. For \$150 (half-price for children) you can drone around the San Francisco Bay area for an hour. The airship holds down two jobs: while it flies passengers, it also carries advertisements on its flanks.

The Skyship 600 has seats for 13 passengers, but generally only 10 are accommodated. "If we had 13

Maureen Tierney/SRW Inc.



heavyweights in here, it could embarrass us," says pilot Dennis Vaughan. Before the blimp is heaved aloft by the ground crew at the "Up ship!" command, bags of ballast are added or subtracted, depending on the passenger load.

From 1,000 feet and at 40 mph, the view is familiar but odd. You can stick your head out the window, look straight down, and see what's normally hidden by fences. Factories and railroad yards, from above their facades, look vulnerable. Cars roll along the freeways like marbles in a pinball machine.

A 25-mph breeze blowing over the coastal hills and thermals rising from the warm ground toss us like a rubber duck in a bathtub. The view changes constantly: one



Maureen Tierney/SRW Inc.

minute I'm looking over the pilot's shoulder at Treasure Island, then the windshield swings up to Alcatraz, on up to the Golden Gate Bridge, then fills with blue sky before the scenery rolls by again in reverse.

The ride doesn't end until the blimp is driven, somewhat unwillingly, to the ground. Running this way and that, the blue suits catch the ropes that dangle from the blimp's nose and hold on tight for the ensuing tug-of-war. Will they bravely hang on if the blimp wins and pulls them into the air? Or will they give up and let us pop up like a cork from a champagne bottle?

Nothing so exciting. The blimp is reined in, ballast bags are added to keep us grounded, and we dismount. That night, my bed rolls like a ship on an unsettled sea.

—Elaine de Man

Your Windsock Stays on My Mind

Ask Karen Holt what she knows about the history of windsocks and she's admittedly vague. "Let's see," she begins, "I know they were used as signal flags by the Japanese and Chinese back in the 1200s. After that, um . . ."

But when it comes to selling them, Holt's a whiz. In 1980, after seeing elegant imported versions gracing the front porches of houses in the Pacific Northwest, she hung one outside her furniture store. When her customers showed more interest in the windsock than in her tables and couches, she decided to start her own


windsock company. This year, Holt expects Colorés International, in Bellevue, Washington, to chalk up close to \$4 million in sales.

Holt has elevated the windsock far above its status as an airport sentinel. Some 200 varieties, which sell for \$3 to \$35, are festooned with national flags and emblems, birds, flowers, rainbows, dinosaurs, and fish. "Carp, a popular design in Japan, are huge sellers for us," Holt says.

Back in the lean years, Holt promoted her product by attending trade shows and sporting events dressed for success—in windsocks. That didn't last long. "I wasn't getting the type of remarks I wanted," she laughs. With a more subdued sales pitch, she approached the National Football League. "I envisioned windsocks flying atop football stadiums instead of the usual pennants. The first time I suggested it to the NFL, they threw me out." Now, however, Colorés carries "win-socks" emblazoned with the logos of football, baseball, and basketball teams. Also under license are windsocks in the shape of Disney characters—Mickey, Minnie, and Donald.

Though the small Colorés office doesn't permit much of a showing of the flag, Holt plans to line the driveway of her lakeside home with her product. "They dance beautifully in the breeze," she says. The end result makes up for her scant knowledge of product history: it's a simple case of beauty over age.

—Michael Rozek



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Update

Pluto's status as a planet (Soundings, June/July 1987) may no longer be in doubt. According to astronomers at the Jet Propulsion Laboratory in Pasadena, California, data collected by the Earth-orbiting Infrared Astronomical Satellite and ground-based telescopes indicate a significant atmosphere on Pluto. The evidence diminishes the likelihood that the planet is actually an asteroid, since asteroids are not known to have measurable atmospheres.

Night-vision goggles (Above & Beyond, June/July 1986) have been involved in military aircraft crashes that have killed 37 people in the last five years. According to *Flightfax*, a newsletter on Army aircraft safety, one reason might be the increasing number and duration of flights made by Army helicopter pilots using the goggles. Because they decrease peripheral vision to 40 degrees, pilots flying close to the ground at more than 100 mph may not see wires, obstacles, or other aircraft in their paths.

National Philatelic Collection, Smithsonian Institution



A 1918 airmail stamp, one of 100 mistakenly printed with an inverted Curtiss Jenny biplane (Calendar, April/May 1986), was sold in May for \$143,000. The anonymous buyer had mailed a bid to the auction, where bidding started at \$100,000.

The ailing Piper Aircraft Corporation ("Hard Times in Hangartown," April/May 1986) has been sold to M. Stuart Millar, a California businessman whose first flight was in a Piper Cub in 1940. Millar hopes to "re-establish Piper as the unchallenged leader with a full range of general aviation aircraft."

Ghostwriters in the sky . . . The Beryl Markham controversy rages on (Update, April/May 1987). In the Letters section of June's *Vanity Fair*, Mary S. Lovell claims that author Antoine Saint-Exupéry, not

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Markham's third husband Raoul Schumacher, contributed to the flier's memoirs. Lovell says her forthcoming Markham biography, *Straight on Till Morning*, contains "a challenge to the irritating assertions regarding Beryl's authorship."

The Frye Company (Soundings, June/July 1987), Jet Boots and all, has been snapped up by Reebok International, whose athletic shoes have become a status symbol.

The Florida Governor's Commission on Space was created in May to determine how the state can maintain a competitive edge in the space program ("All Quiet on the Launch Pad," February/March 1987). "For almost 40 years, Florida has been America's gateway to the stars," said Governor Bob Martinez. "The space industry has become a critical component of our economy."

A 16-foot NASA Orion rocket and two sounding rockets, equipped to research the effects of thunderstorms on the ionosphere, ignited after a lightning strike on the

Wallops Island, Virginia launch pad during a storm on June 9. Astonished employees watched the impromptu launch of the Orion, which flew about 300 feet horizontally straight into the ocean. The sounding rockets rose 15,000 feet and landed more than two miles away.

A prototype Navy airship will be completed by a Westinghouse-Airship Industries team by 1991. Westinghouse-Airship beat out Loral Systems, the new owner of Goodyear's aerospace division, in bidding for the surveillance blimp contract. The Sentinel 5000, more than twice the size of today's Goodyear blimps, is designed to stay aloft with a crew of at least 12 for up to three days at a time.

The Boeing 737 has become the world's best-selling airliner, surpassing the 1,831-mark set by the Boeing 727 before production ceased in 1984. Recent orders for 20 737s broke the record by 11.

Leather flight jackets, long prized by Naval aviators, will become standard issue for Air Force pilots. Air Force Secretary

Edward Aldridge ordered the jackets put on flight status as part of a plan to entice pilots to remain in the service instead of switching to civil airline jobs.

A dog's lawsuit against USAir was dismissed by a federal judge in Rochester, New York, in May. The Feinstock family, owners of a 15-year-old dog named Ari, filed the suit on behalf of the canine when baggage handlers left Ari circling on a conveyor belt in Tampa, Florida, after the Feinstocks had caught their flight home. Judge Michael Telesca ruled that Ari was not a person and therefore did not have the right to sue anyone. Carl Feinstock, though disappointed by the decision, said it "was not totally unexpected."

A pyramid scheme called Airplane crashed and burned in Rockville, Maryland, in May when police arrested 11 alleged organizers among a group of approximately 200 players. Pilots, Crew Members, and Passengers were to ante up \$1,500 with the understanding that they would receive \$10,000 by recruiting more players.

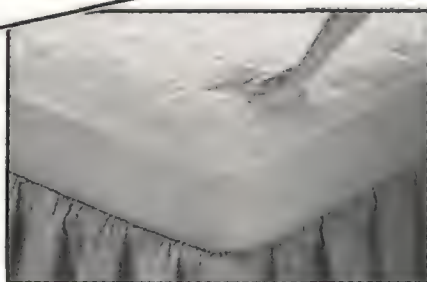
—Patricia Trenner

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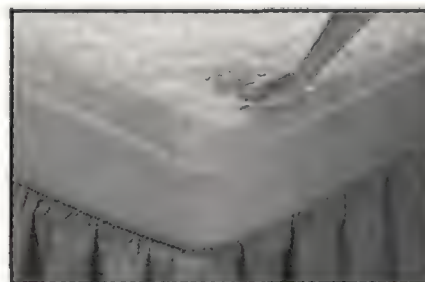


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Tilt!

"Where would you like to be sent?" the major asked, smiling earnestly.

I stared back in astonishment. I couldn't help wondering if something had happened while I was overseas. When the Army Air Forces sent me to New Guinea to fly P-39s, no one had asked me if I wanted to go. Had Eleanor Roosevelt gotten to Hap Arnold?

My new friend was looking at me anxiously. Where would I like to be sent? Well, let's see. I'd spent almost two years in the tropics, so someplace cool would be nice. I'd been away from my beloved northern New England for a long time, so how about there?

I was hesitant, but the major was all for it. He smiled again and wrote carefully: "Park, E. Capt. 5th AF: Cool climate—far northeast."

Five days later my orders were cut: Yuma Army Air Base, Yuma, Arizona. I felt a wry sense of relief. Everything was okay with the country after all.

Yuma was a new, unpretentious base, spread flat on the desert, whipped by dust and blasted by heat, and assigned to training gunners on bomber crews. The base had a lot of fighters parked on the tarmac: my old P-39s and their big sisters, the faster P-63s.

At Yuma I learned that the P-63 also came in orange—*bright* orange, with armored doors and armor glass in the windows. And instead of a cannon in the nose cone, it had a lamp.

I did not want to fly this airplane. But I hadn't wanted to go to New Guinea and I hadn't wanted to come to Yuma, so the Army, being what it was, quickly assigned me to fly it. Two officers drove me out to it in a jeep. "Just take her up and see if she works," they said.

"What is she?" I asked dubiously.

"An RP-63," they answered. "We call her the Pinball Machine."

Seeing my puzzlement, one of them climbed into the cockpit and turned on a switch. Another bumped the orange fuselage hard with his fist. The spotlight in the nose blinked at me.

"She's a target," they explained. "Your gunnery students shoot at her with bullets

that powder when they hit. That makes the light go on, and they know when they've scored."

"She's radio-controlled," I suggested.

"Wrong," they said. "A guy flies her. He makes real fighter passes with her, and he gets shot at with those funny bullets. He's protected with all that armor, but it makes her a little heavy, and we need to know whether . . . I mean how she flies. So you take her up, okay?"

"No," I said. But they just laughed. I

Barbara Gibson



reassumed my soldierly mien, got my gear, and climbed in.

The aluminum skin was only a quarter of an inch thick, but when the door swung shut with a heavy clang, I felt as though I had locked myself in a safe.

I started up and rolled ponderously to the end of our longest runway, a two-miler. When I got a green light from the tower, I poured on the coal. The Pinball Machine groaned forward. I waited for what seemed a proper speed, then eased back to get the nose up. Nothing happened. We howled on toward the cacti. Finally, I felt a little lightness, and we lumbered into the air.

Gear and flaps up, the Pinball could move. Climbing was a little slow, but at 15,000 feet, where we would do our stuff for the aerial gunners, we clipped along nice and fast. I pretended to make a pass, turning in, then abruptly away. The airplane stayed with me, but I had an instinctive aversion to getting it anywhere near a stall. After an hour of maneuvers, I decided I'd been brave for long enough.

I struggled to slow down to a speed where I could lower the gear. Then, as I slid into the pattern, I throttled back. Immediately my stomach rose as the airplane dropped from under me. To keep it in the air I had to pile on throttle again and get the speed back up to about 160 mph. I kept adding power, dragging it in to the end of the strip. The instant I eased off, the tires shrieked on the concrete.

When it came time to try the Pinball Machines as targets, I felt it only proper that younger, less important pilots should have the chance to show what this remarkable plane could do in simulated combat. At first, the RP-63 worked fine. The gunners loved being able to shoot live ammunition at a live target. Their "frangible" bullets were all different colors, and after their gunnery missions, they'd crowd around the Pinball Machine looking for their hits.

Then one day, one of my young pilots took off in the Orange Peril to make passes at a bomber. An hour and a half later, he dropped in to see me, dragging his parachute canopy behind him. His engine had just stopped dead, he said.

We investigated and found that a frangible bullet had hit the air intake and "franged" all over the screen that was supposed to protect it. A few grams of powdered bullet had been sucked into the cylinders and had frozen the engine.

A few days later another young tiger bailed out. Again, he'd been hit on the intake. We suspended gunnery training missions until the intake was modified with an opening shaped like a clamshell. You had to be a sniper to get a bullet inside that.

I believe later models had intakes flush with the fuselage, but I never had the pleasure of flying them. The war ended, and I headed for the cool northeast.

Yuma turned out to be my favorite base. Perhaps because it really was a miserable place, the people there made a special effort to enjoy life. In one gunnery course, we shot clay pigeons from the back of a rapidly moving truck. I've been pretty good at skeet ever since.

—Edwards Park

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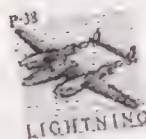
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Anniversaries...

1709

August 8 A small model hot-air balloon is demonstrated to King John V of Portugal in the Casa da India customs house in Lisbon. It ascends 12 feet before it is destroyed to avoid setting the drawing-room curtains on fire.

1819

August 2 Charles Guille makes the first parachute jump in the United States. The intrepid Frenchman waited until a summer storm blew over Long Island, New York, then ordered his balloon released. It was immediately blown into a tree, large branches of which remained in the rigging as the balloon ascended. When he reached 8,000 feet, Guille cut the ropes supporting the basket. He fell 300 feet before the parachute opened, but his troubles did not end with his landing: the balloon wafted on for 30 miles before descending on Oyster Bay, whose residents demanded \$200 for its return. New Yorkers took up collections in coffee houses to pay the ransom, and Guille—who had come to the United States to make his fortune—left for Philadelphia, hoping for better luck.

1883

August 26 The volcano on the Dutch East Indies island of Krakatoa erupts, hurling five cubic miles of earth up to 50 miles high. The explosion, which was heard 2,000 miles away in Australia, created 120-foot tsunamis, killed more than 36,000 people, and blew away two-thirds of the island. Volcanic dust in the atmosphere produced spectacular sunsets and lowered solar radiation for several years.

1932

August 13 The Granville Brothers Gee Bee R-1 Super Sportster makes its first flight at Springfield, Massachusetts. Major James Doolittle set a speed record of 252 mph in the R-1 at the National Air Races in Cleveland, Ohio, the following month. The fat, stubby Gee Bees were as vicious as they were fast—the few that were built killed almost every pilot who dared to fly them.

1935

August 15 Aviator Wiley Post and humorist Will Rogers are killed when they crash after an engine failure on takeoff near Point Barrow, Alaska. Post ignored warnings that his hybrid aircraft—a Lockheed Orion fuselage with Lockheed Explorer wings and oversize Fokker Trimotor floats—was unstable at low speeds.

1937

September 18 Skywriting at night debuts when the words "Green River" appear over New York City. Andy Stinis of the Skywriting Corporation of America had to consult an astronomical calendar to schedule the liquor advertisement for Oldtyme Distillers; the words could be read only by the light of a full moon.

1939

September 5 Air race pilot Roscoe Turner wins an unprecedented third Thompson Trophy and retires from racing at age 43. The flamboyant Turner flew with a lion cub named Gilmore until the cub outgrew the cockpit and quit the race circuit at the age of six months. Turner mailed \$40 for fresh meat to Gilmore's caretakers every month until the lion died,

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Air-race cub Gilmore outgrew the cockpit and owner Roscoe Turner in only months.

then had him stuffed and placed in his trophy room. Today, Gilmore shares quarters with a spacesuit collection and other fragile artifacts in an environmentally

Jimmy Doolittle was one of the few to survive speed runs in the ill-natured Gee Bee.

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controlled storage vault at the National Air and Space Museum's Garber Facility.

1940

August 22 At the Martin factory at Baltimore, Maryland, the keel is laid for the first of the Navy's largest flying boats, the enormous PB2M Mars. It was the first aircraft accorded Navy keel-laying and launching ceremonies.

1943

August 1 Junior Lieutenant Lydia Litvak of the Soviet Union's 73rd Guards Fighter Air Regiment, who was credited with 12 aerial combat victories, is killed in action in a Yak fighter at age 22.

1947

September 18 The U.S. Air Force begins operations as an independent service within a new unified armed services established by the National Security Act of 1947 (see Events, September 18-20). The USAF adopted a blue uniform for the coming Jet Age, but retained fond memories of Army Air Corps songs, khaki, and 50-mission-crash caps.

1952

August 4 Two U.S. Air Force Rescue Service Sikorsky H-19s arrive in Wiesbaden, Germany, after making the first transatlantic crossing by helicopter. The overwater leg, with several refueling stops, took 42 hours.

1954

August 1 The Convair XFY-1 Pogo makes its first vertical takeoff and landing. Initial flight tests were conducted with the Pogo tethered on cables strung from the

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The vertical-takeoff Pogo made flying the Harrier look like child's play.

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What do you get when you cross a Stratocruiser with a blimp? A Guppy.

200-foot-high ceiling of a blimp hangar. The gimballed pilot's seat was adjustable for vertical and horizontal flight. After backing down to a landing, the test pilot commented, "It's awful hard to fly an airplane looking over your shoulder." The development program was canceled in 1956; the vertical-takeoff-and-landing concept resurfaced 10 years later in the Hawker Harrier. Instead of rotating the entire aircraft to direct its thrust, the Harrier uses rotating nozzles that direct thrust as required.

1960

August 16 During Air Force research into jet aircraft escape systems, Captain Joseph W. Kittinger Jr. jumps from a balloon gondola 102,800 feet over the New Mexico desert. He fell for more than four minutes at up to 614 mph, stabilized and slowed slightly by a six-foot-wide parachute used to prevent an uncontrollable spin. "Earth, sky, and departing balloon revolved around me as if I were the center of the universe," he reported. Kittinger landed safely on grass, sand, and sage after his main parachute opened at 17,500 feet.

August 19 A 300-pound data capsule equipped with a radio beacon is ejected from the Discoverer 14 satellite and descends via parachute to 8,000 feet, where it is snatched up by an Air Force Fairchild C-119 transport. Capsule recovery via aircraft or boat was used throughout the Discoverer program because more sophisticated data transmission techniques had not yet been developed. Today, companies researching space-based manufacturing are considering resurrecting this retrieval method.

1962

September 5 Fragments of a Soviet satellite land in Manitowoc, Wisconsin.

September 19 The Aero Spacelines 377 PG (Pregnant Guppy), a converted Boeing Stratocruiser and one of the world's silliest-looking aircraft, makes its first flight.

Payloads such as large booster rockets were accommodated by enlarging the fuselage to nearly a blimp's dimensions.

1964

September 21 The North American XB-70A Valkyrie Mach 3 bomber prototype makes its first flight. North American built two of the futuristic delta-wing Valkyries, but the second was lost in a 1966 collision with a Lockheed F-104 during a photo flight. In the face of escalating costs and a preference for nuclear-tipped ballistic

NASM



The only battle the Valkyrie fought was over politics and economics.

missiles over a defenseless strategic bomber, the program was shelved in 1968. The surviving Valkyrie was flown to the Air Force Museum in Dayton, Ohio.

1978

August 12 The International Sun-Earth Explorer 3 is launched from Cape Canaveral to study the solar wind. In 1983 ISEE got a new name and a new job: as the International Cometary Explorer, it was sent off to rendezvous with Comet Giacobini-Zinner in 1985. After ICE became the first spacecraft to fly through the tail of a comet, it went into orbit around the sun, where it will remain until NASA switches it to an Earth orbit in 2013. The agency hopes to eventually retrieve ICE and turn it over to the National Air and Space Museum.

1983

September 26 A Soviet launch vehicle carrying a Soyuz T capsule explodes on the launch pad, but the crew ejects safely.

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Through August 9

"Twenty-five Years of Manned Space Flight," Smithsonian Traveling Exhibition. At the Museum of Flight, Seattle, WA, (206) 764-5700.

"Black Wings: The American Black in Aviation," Smithsonian Traveling Exhibition. At Pioneers' Museum, Colorado Springs, CO, (303) 578-6650.

August 7-9 Abbotsford International Aviation Exhibition and Airshow. Canadian Snowbirds, past and present military aircraft flybys, civilian performers. At Abbotsford Airport, British Columbia, (604) 859-9211.

August 8 & 9 Open Cockpit Weekend. Approximately 16 World War II and contemporary fighters, bombers, and helicopters, as well as simulators, will be open to visitors. At New England Air Museum, Bradley International Airport, Windsor Locks, CT, (203) 623-3305.

August 9-15 Ninety-Nines International Women Pilots Convention. This aviation association, originally led by Amelia Earhart, was named for the number of original charter members. At Hotel Vancouver, Vancouver, British Columbia. Contact Kate Merry, (604) 535-1308.

August 15 Third annual "Day at the Airport." Aerobatic performers, airplane

It's a day at the airport and a night of nostalgia at Bloomington, Illinois.



Courtesy Prairie Aviation Museum

rides, air traffic control tower tours, antique cars. Period clothing and military uniforms are welcome at the USO Hangar Dance, which will feature the music of the 1940s. At Bloomington Normal Airport, Bloomington, IL. Prairie Aviation Museum, (309) 827-8039.

August 15 & 16 Reading Airshow. Thunderbirds perform on opening day. At Reading Municipal Airport, Reading, PA, (215) 372-4666.

Caroline Sheen



Swing low, sweet parachute: the Army's Golden Knights perform all summer.

Quonset International Airshow. Golden Knights, F-14, F-18 flybys, civilian acts. Thunderbirds perform on the 16th. At Quonset State Airport, North Kingstown, RI, (802) 496-3473.

August 29 & 30 Flight '87 Airshow. Golden Knights, Concorde, military and civilian aviation demonstrations and ground displays. Thunderbirds perform on the 30th. At Schenectady County Airport, Schenectady, NY, (518) 382-0041.

September 1-October 15 "Black Wings: The American Black in Aviation," Smithsonian Traveling Exhibition. At Massachusetts Port Authority, Logan Airport, Boston, MA, (617) 561-1628.

September 5 & 6 Pennsylvania International Airshow. Blue Angels, Golden Knights, current military aircraft flybys. At Harrisburg International Airport, Middletown, PA, (717) 322-2426.

September 5-7 Cleveland National Airshow. The Cleveland air races were a national sensation during the 1930s and '40s. Today the airshow, held every Labor Day weekend, carries on the grand

tradition. Thunderbirds, Golden Knights, past and present military aircraft, civilian performers. At Burke Lakefront Airport, Cleveland, OH, (216) 781-0747.

September 11-13 "Gathering of Homebuilts" hosted by the Chicken Little Air Force—"We never fly when the sky is falling." At Columbia Airport, Columbia, CA, (415) 581-8728.

September 13-October 12 "Twenty-five Years of Manned Space Flight," Smithsonian Traveling Exhibition. At Children's Museum of Oak Ridge, Tennessee, (615) 482-1074.

September 17-20 The 24th annual National Championship Air Races. Homebuilt airplanes and souped-up World War II fighters compete daily. Eagles Aerobatic Team, P-38, wingwalker. At Stead Airport, Reno, NV, (702) 826-7500.

September 18-20 Festival of Flight celebrates the 40th anniversary of the Air Force. Aircraft flyby, gala dinner with military VIPs, two-day air fair. At Wright-

U.S. Air Force



Patterson Air Force Base, Dayton, OH, (513) 255-3334.

September 21-26 U.S. National Aerobatic Championships and airshow (closing day). This year's competition will determine the team that will represent the nation in next year's international contest in Canada. At Grayson County Airport, Denison, TX, (901) 756-7800.

September 26 & 27 The Great Kansas Airshow. Canadian Snowbirds, Golden Knights, military flybys, aerial refueling

demonstration, World War II aircraft, civilian aerobatic performers, Air Force Academy band. At Forbes Field, Topeka, KS, (913) 862-9649.

International Launches

August 23 Japanese National Space Development Agency, Tanegashima Space Center: Engineering Test Satellite 5, via an H-1 launcher.

August 28 Arianespace, Guiana Space Center, French Guiana: Australian Aussat K3 and European Space Agency ECS 4 communications satellites, via an Ariane 3 launcher.

Organizations wishing to have events published in Calendar should submit them at least three months in advance to Calendar, Air & Space/Smithsonian, National Air and Space Museum, Washington, DC 20560. Events will be listed as space allows.

—Patricia Trenner

CAPTURE HISTORY

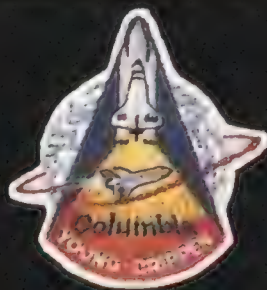


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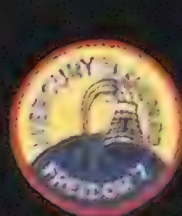
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First Lunar Landing
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In the Museum

A Star of the Sky

During the period between the world wars, a time known as the Golden Age of Aviation, the United States developed an infatuation with aviators and their airplanes. Pilots like Charles Lindbergh, Wiley Post, and Amelia Earhart became national heroes as front-page headlines trumpeted each new record and racing victory, and delirious ticker tape parades through New York City celebrated particularly arduous exploits. Also a time of rapid technological advancement, the Golden Age emphasized the possibilities and romance of air travel.

Flying in the forefront were sleek Lockheed Vegas, their numerous flight records and racing victories justifying the boast "It takes a Lockheed to beat a Lockheed." As evidence of the Vega's major role in aviation's formative period, the National Air and Space Museum has two on display: Amelia Earhart's glossy red and gold aircraft in the Pioneers of Flight Gallery and Wiley Post's white and blue *Winnie Mae* in the Flight Testing Gallery. Both are later models, with round cowlings that improved the flow of cooling air through the engine and distinctive spat-like "pants" to smooth airflow over the wheels.

NASM



Amelia Earhart and Vega met with Lockheed's Allan Loughhead, Carl Squier, and Lloyd Stearman (above). After Post and Gatty's flight, the Winnie Mae was eased on down Fifth Avenue for display.

UPI/Bettmann Newsphotos



They sit nose high in their galleries, graceful survivors from the years of Art Deco and bootleg whiskey.

The Vega story begins with two brothers from California, Allan and Malcolm Loughead (pronounced Lockheed). Allan was an aviator and his older brother Malcolm was a mechanic. In 1913 the brothers, then living in San Francisco, designed and built a seaplane. Although it was their first airplane, they named it the Model G to imply the existence of Models A through F.

In 1916 Allan and Malcolm formed the Loughead Aircraft Manufacturing Company in a Santa Barbara garage. Aided by an ambitious young airplane designer named John "Jack" Northrop, they built the F-1, another seaplane, and then the S-1, a single-seat biplane. But demand for new airplanes waned after World War I, and the brothers gave up on the airplane business. Malcolm moved to Detroit and developed the Lockheed Hydraulic Brake, using the phonetic spelling of his name. Allan sold real estate in the Los Angeles area.

In their spare time Allan and Northrop worked on an airplane design that borrowed the monocoque (French for "single-shell") design of their S-1. The result was the Vega, a sturdy, high-wing monoplane named after one of the brightest stars in the sky. Allan received financing from a Los Angeles businessman, who asked that he name the new company Lockheed to capitalize on the success of Malcolm's brake. Perhaps sick of the pronunciation "Log-head," Allan agreed.

Although not incorporating any new design elements, the Lockheed Vega was an ideal combination of form and function.

The wings were internally braced, eliminating drag-producing struts and wires, and the cigar-shaped fuselage was made of plywood, its monocoque design resulting in a light, tough airplane. Later Vegas, with the wheel spats and engine cowling, combined solid strength with the graceful curves of a Machine Age sculpture.

Building monocoque fuselages had been too time-consuming for mass production until Lockheed began constructing Vega fuselages in a special concrete mold. The three layers of plywood strips needed to form one side of a fuselage were glued together inside the mold, which had a wooden lid with an inflatable rubber bag on the inside. Workers sealed the lid and inflated the bag, which pressed the wood layers together while they dried. It was a simple matter to fasten the fuselage halves together and cut out the windows and door.

Shortly after its maiden flight on July 4, 1927, the first Vega, christened the *Golden Eagle*, set a speed record between Los Angeles and Oakland. Although the airplane disappeared without a trace on a California-to-Hawaii race a month later, the design made an impact. In 1928 Hubert Wilkins and pilot Ben Eielson flew over the Arctic Ocean in a Vega. Other Vegas were flown by Roscoe Turner, Jimmy Mattern, and Ruth Nichols.

Amelia Earhart had accumulated a string of firsts by the time she disappeared over the Pacific 50 years ago. She was the first woman to fly across the Atlantic (though only as a passenger), the first person to fly from Hawaii to the U.S. mainland, the first woman to make a solo nonstop crossing of the Atlantic, and the first woman to fly a

solo nonstop flight across the United States. She made the latter two flights in the Vega 5B on display in the Museum.

Earhart said that she made her Atlantic crossing "for the fun of it," but it was a dangerous journey, even in the normally dependable Vega. Earhart took off from Harbor Grace, Newfoundland, on May 20, 1932, headed for Europe. Nearly 15 hours later, after suffering a broken altimeter and severe icing conditions, Earhart decided to land in Northern Ireland when gas from a fuel line began leaking into the cockpit.

After returning to the United States, Earhart flew her Vega on the transcontinental hop, then sold it for \$7,600 to the Franklin Institute, a museum in Philadelphia. She kept her faithful Wasp engine for her new Vega and had a replacement installed in the old one. The Franklin Institute kept the airplane on display until 1966, when it gave the craft to the Smithsonian. Following a decade's storage at the Paul E. Garber Facility in Suitland, Maryland, Earhart's airplane received new paint and a touch-up and went on display in the new Museum building when it opened in 1976.

Like Earhart's, Wiley Post's aviation career ended on a tragic note: a crash killed him and his passenger, fellow Oklahoman Will Rogers, on August 15, 1935 (see Calendar). The deaths of the daring aviator and the cowboy philosopher shocked the country.

In 1926 Post had been just another Oklahoma oilman with a desire to fly when an oil rig accident cost him an eye. He took advantage of the injury by using part of his workman's compensation to buy his first airplane.

Post sold that airplane when he got a job as personal pilot for oilman F.C. Hall, who bought a Vega and named it *Winnie Mae* after his daughter. In 1930 Post flew Hall's second Vega, also named *Winnie Mae*, in an air derby between Los Angeles and Chicago. The Vega's sleek aerodynamics and powerful Pratt & Whitney engine enabled Post to take first place over four other Lockheeds. Pilot Art Goebel came in second, flying the first *Winnie Mae*, "repainted a bit, slightly changed, and under a new boss," Post later wrote, "but still the good old airplane in which I had spent so many hours and on which many of my dreams were based."

It was *Winnie Mae* number two that made those dreams come true. Post was catapulted into fame in 1931 when he flew the Vega around the world in eight days

For posterity, pilot Post posted his achievements on his airplane's posterior.

NASM





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with Australian navigator Harold Gatty. Post bought the *Winnie Mae* from Hall, then flew it on a solo world flight in 1933. Always interested in aeronautical science, he made the solo flight with one of the first radio direction finders and "Mechanical Mike," an early Sperry autopilot. When he touched down at New York's Floyd Bennett Field, Wiley Post became the first pilot to circle the world twice and the first to do it alone.

Post used the *Winnie Mae* to pursue an interest in high-altitude research flight, equipping the Vega with a supercharger and special detachable landing gear and wearing the first successful pressure suit. Post also made four attempts at high-altitude cross-country flights. All ended in forced landings, once because someone, perhaps hired by a rival pilot, had sabotaged *Winnie Mae*'s engine by dumping emery dust in it. At one point on the second try the *Winnie Mae* reached 340 mph, well over its normal top speed of 192 mph, clear evidence that Post had found a powerful tailwind that would, years later, be identified as the jet stream.

The *Winnie Mae*, like its pilot, became a celebrity. Post had considered letting the Smithsonian acquire the airplane even before his solo world flight, and in 1935 Oklahoma congressmen introduced a bill authorizing the government to purchase the Vega for \$25,000 and put it on display in the Smithsonian Institution. The bill came up for consideration the day Post died: in the midst of national mourning it passed easily. Paul Garber, at the time assistant curator for aeronautics at the Smithsonian, traveled to Oklahoma to take possession of the veteran Vega. He found the airplane bearing a black ribbon on its propeller, placed in tribute to the Oklahoma oil driller who had become an American hero, flying one of the Golden Age of Aviation's greatest airplanes.

—Tom Huntington

Lights, Camera, History!

The Museum's spaceflight artifacts, from spacecraft to watches worn by astronauts on the moon, are the most obvious and visually appealing products of the U.S. space program, but they are only a small part of the story. The human side—the people, thinking, and anecdotes behind the creation of the artifacts—is much more difficult to capture. How can you put an idea in a glass case, or exhibit a collaboration? For the Museum's Space Science and Exploration Department, oral and video histories provide at least part of the answer.

Oral histories are already a valuable part of the Museum's research, and last year Space Science and Exploration curator David DeVorkin began investigating how video histories can enhance archival collections throughout the entire Smithsonian Institution. DeVorkin is directing an experimental science history project sponsored by the Smithsonian and funded by the Alfred P. Sloan Foundation, which supports historical research and activities that promote the understanding of science. The four-year-long Issues in Modern Science video project qualifies on both counts.

DeVorkin and the project's historians are videotaping interviews with groups who recount how certain scientific advances took place. For the interviews, scientists who worked together on notable projects—for example, Herbert Friedman and his pioneering X-ray astronomy group at Washington, D.C.'s Naval Research Laboratory—discuss the project's conception and development, as well as the nature of the instruments involved. The group format encourages some liveliness, allowing colleagues to argue or correct one another and add missing pieces to one another's accounts. Says DeVorkin, "I'm impressed with how candid people can be under the lights."

So far DeVorkin's group has finished four hours of interviews with Friedman's group, which launched a variety of experiments on sounding rockets and small satellites in the 1940s and 1950s. The program has already logged over 30 hours with scientists exploring aspects of "science in the national life."

The Smithsonian Archives will keep a videocassette library of the video project. Scholars and researchers will have access to transcripts as well as the videos themselves, but DeVorkin stresses that the videotapes are raw data, not finished products like history books, and must be used carefully.

The Space Science and Exploration Department already has a substantial oral history project in its archives. The Space Astronomy Oral History Project, begun in 1981 with the support of the Smithsonian's Scholarly Studies Program, the National Aeronautics and Space Administration, and the Naval Research Laboratory, includes over 250 hours of interviews with more than 60 space scientists. Conceived to preserve the story of the beginnings of space astronomy while the people involved were still alive, the project includes interviews with James Van Allen, who discovered the Van Allen radiation belts, and Frank Drake, an early proponent of the search for extraterrestrial intelligence.

Complementing the space astronomy project is an oral history project that includes over 200 hours of interviews with more than 75 people involved in developing the Hubble Space Telescope.

A new space history project, under the auspices of the Glennan-Webb-Seamans Fund for Research in Space History, will include both oral and written records. The fund, named after Keith Glennan and James Webb, the first two administrators of NASA, and Robert Seamans, who served under them, will support "historical study of the role of management in the space program," according to Martin Collins, director of the fund. Curators have already completed almost 20 hours of interviews with Webb and have started interviews with Glennan, Seamans, and others. The fund will expand the Museum's oral history efforts to include scientists, engineers, and administrators who participated in the space program in NASA, the military, the aerospace industry, and academia. It will also support the establishment at the Museum of a central catalog of historic documents archived all over the country—for instance, Glennan's papers at the Eisenhower Library in Abilene, Kansas, and Webb's papers at the Truman Library in Independence, Missouri. This clearinghouse will be a valuable source of information for scholars interested in a thorough history of the U.S. space program.

—Linda Billings

George Hall



Art Scholl thrilled thousands with stunts in his de Havilland "Super Chipmunk."

The Stunt Man

When he died filming a portion of *Top Gun* on September 17, 1985, Art Scholl was the number-one stunt pilot for the movies. Besides piloting airplanes for many TV episodes, Scholl also flew for films like *The Great Waldo Pepper*, *The Right Stuff*, and *Blue Thunder*. Thousands of Museum visitors have seen his work in the IMAX film *Flyers*: he flew for the scene in which a pilot rescues a fallen wingwalker. Shot over

the Grand Canyon, the sequence required Scholl to dive his airplane and match the wingwalker's descent, then pull out with the fallen man clinging to his airplane's wing. It was a tricky stunt, and only Scholl's expert flying kept him from crashing his Stearman into a mesa.

Now the Museum will have more to remember Scholl by. In his will, the stunt pilot left one of his two modified de Havilland Chipmunks to the Museum. Constructed as a military trainer by de Havilland of Canada, the little airplane was customized by Scholl with retractable landing gear and a smoke generator. Scholl used the brightly colored "Super Chipmunk" to thrill thousands with his aerobatics, sometimes flying upside down just a few feet from the ground.

This summer the airplane was trucked from Rialto, California, to the Museum's Garber Facility. According to Robert Mikesch of the Aeronautics Department, the Super Chipmunk will be exhibited at the Garber Facility until an exhibit theme is developed for it, or until it can be displayed at the facility planned for Washington's Dulles airport.

—Tom Huntington

Museum Calendar

Except where noted, no tickets or reservations are required. Call Smithsonian Information at (202) 357-2700 for details.

Correction: The William Phillips display, "Into the Sunlit Splendor," will be in Gallery 211 until December 1987, not June 1988.

Summer Concert Series. Music by U.S. armed services bands, selected weekdays on the west terrace, noon to 1:00 p.m.
Airmen of Note—Air Force jazz, August 26. **Commodores**—Fridays in August.
Country Current—Navy country, August 20 and 27, September 3 and 10. **Army Blues**—August 10.

Fly-by-Night Family Nights. Demonstrations, games, films. Fridays through September 4, 6–9 p.m.

August 1 Monthly Sky Lecture: "William Herschel: Natural Historian of the Heavens." Michael Dennis, Smithsonian pre-doctoral fellow. Albert Einstein Planetarium, 9:30 a.m.

September 5 Monthly Sky Lecture: "Supernova 1987a." David DeVorkin, NASM curator, history of astronomy. Albert Einstein Planetarium, 9:30 a.m.

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Flight of the Lighthawk

A green air force soars
with the eagles.

by Nancy Shute *Photographs by George H. H. Huey*

From the left seat of his Cessna Centurion, Michael Stewartt sees below him a vision so lovely it almost transcends description.

An oasis of high country in the New Mexico desert, the 10,000-foot Jemez Mountains southwest of Los Alamos are smallish compared with the nearby Rockies. But this circle of volcanic peaks and mesas blanketed in ponderosa pine possesses a delicate beauty so powerful that the Pueblo Indians consider the entire range sacred ground.

Stewartt wants to protect that beauty, as does his passenger, Ted Davis, an Albuquerque physician and president of a citizen's group called Save the

Like the hawks and owls that populate the Cascades, a Lighthawk Cessna feels at home in verdant valleys (left).

Lighthawk director Michael Stewartt educates reporters in aerial navigation at the Grand Canyon.



Jemez. Today's mission: scope out the proposed route of the \$29.5 million Ojo Line Extension power line project, designed to bisect the Jemez en route to the Los Alamos National Laboratory.

Davis believes the mountain route would destroy Jemez wildlands and thousands of Pueblo ruins and worship sites scattered across the mesas, some of which are still used. He wants photographs as evidence when Save the Jemez challenges the route. "No one has ever really seen where they are proposing to put this," Davis says. "No one truly comprehends how remote and beautiful this area is."

Stewartt does—he knows the Jemez as well as he knows his home airport. He starts a photo run over a 15-mile-wide caldera left by a volcanic explosion more than 10 million years ago that would have made Mount St. Helens sound like a sneeze. "Nice elk habitat here," he observes, a jaunty if incongruous figure in shirtsleeves and a sheepskin mitten to pad his palm from the chilly control wheel. "Okay, Doc," he says, "what's your druthers?"

"Can we get a little side view of Redondo Peak?" Davis asks, rummaging through a bag full of cameras and lenses. Stewartt banks right, and Davis snaps away as the snow-dusted slopes of the mountain roll past.

Stewartt turns north to an isolated

mesa, spiralling down until the faint tracings on the mesa top become the ruins of Tsiping pueblo, with its *kivas*, circular ceremonial rooms, carved eight feet into solid rock some 800 years ago. Stewartt descends until the Cessna is skimming the rim of the ancient city. "Fantastic!" Davis crows, snapping frantically. Stewartt keeps glancing from the ruins to the canyon wall ahead, waiting until the last possible second. "I

gotta turn, Ted." Davis clicks off one more frame as the airplane noses above the cliff. He calls, "Let's go around again."

After about an hour and a half in the air, Stewartt, Davis, and six rolls of exposed film arrive at Coronado Airport, just south of Albuquerque. Stewartt, the chief pilot and executive director of Project Lighthawk, is as satisfied as his customer.



Until benefactors provided some much-needed support, Stewartt soloed Project Lighthawk (above).

Environmentalists fly with news reporters, then discuss the issues raised by what they've seen.



Since he first launched Lighthawk six years ago as a flying service for conservationists, Stewartt has flown hundreds of missions, from the exotic—tracking grizzlies in the Montana wilderness—to the prosaic, shuttling local officials to public hearings across the Western landscape. Nonprofit Lighthawk flies at bargain rates—\$35 an hour for a six-place 210 Centurion, a fraction of the cost of regular charter

Lighthawk pilots and clients have zeroed in on a mine encroaching on the Grand Canyon.



rates—and has opened the skies to grassroots organizations. Save the Jemez, for one, is delighted. "Michael gets us wherever we need to go," Davis says. "Lighthawk is like a sky tripod."

At 38, Stewartt could pass for the young bush pilot he was 10 years ago: his enthusiasm belies the wisps of gray streaking his blond hair. He grew up in Tucson, back when it was a pretty little town flowering in the desert. Though infatuated with its beauty, he left home at 15, opting for a Minnesota boarding school instead of the disharmony of his parents' failing marriage. Although as a teenager he dabbled in high-adrenaline adventures, including skydiving, in 1967 he set off for Stanford University in Palo Alto, California, thrilled at the prospect of diving into big-time academia. Once there, he was bored stiff.

So Stewartt did what any self-respecting 1960s college freshman would do—he dropped out. But instead of wandering off to Haight-Ashbury, he headed for Canberra, Australia. "I spent a year rambling around, having the time of my life working at odd jobs and reading philosophy," he explains. "Nietzsche and Mount Kosciuszko!"

When he made his way back to the States the following year, his growing fascination with skydiving spilled over into flying. He was hooked after one lesson. To pay for the training he needed for his private pilot license, he took a job in a copper mine, herding ore 2,000 feet underground. A job as a lineboy at the Roswell, New Mexico airport financed his commercial, multi-engine, and instructor ratings.

Stewartt then switched to a career in aviation, flying for commuter airlines in Colorado and the Caribbean; as a pilot and medic for Wings of Hope, ferrying Indian settlers into the Guatemalan jungle; and as a bush pilot in Nome, Alaska, flying Inuits to and from their ice-locked villages.

When Stewartt returned to Tucson in 1974, he found the wildland where he grew up buried under highways, burger joints, and multiplex movie houses. His verdict on his hometown: "It was trashed."

The notion of enlisting aviation in conservation came to Stewartt the following year, when he offered to assist a Santa Fe environmental group opposed



to construction of a massive coal-fired power plant on the Kaiparowits Plateau in southern Utah. A press conference was planned to spread the word that pollution from the plant would mar views of the Grand Canyon and other nearby parks. One of the TV networks was sending a camera crew. "I said, 'None of these folks are ever going to see what we're talking about,'" Stewartt recalls. "'Why not get airplanes and show 'em?' Everybody said, 'Great idea, Michael, you do it.' So I got four planes, three more pilots, and did it. And I realized that conservation work in the West needs aviation."

Project Lighthawk, named for a bird envisioned by Stewartt as one "whose purpose is to shed light," had taken off in his imagination, but keeping the

Cessnas can fly high, but Stewartt finds the low road through the mountains irresistible.

dream airborne proved to be a challenge even for his formidable persuasive talents. Environmentalists and potential donors were skeptical of the value of such an expensive commodity to a movement that has never had enough cash. After two years of trying to raise seed money, a dead-broke and disillusioned Stewartt gave up and took off for another bush-piloting stint in Nome. Soon he tried again, failed, and gave up on the idea, moving to Colorado to work as a massage therapist.

But Stewartt was a con artist in the positive sense of the word: one who in-

spires confidence in others. In 1979 he laid the idea of a green air force before a wealthy rancher, who offered the loan of a Helio Courier bush airplane and 150 hours' worth of fuel. The following year, Project Lighthawk finally soared, flying its first clients over a proposed dam site on Colorado's Gunnison River. "It was an instant success after years of trying," Stewartt observes wryly.

In 1981 donors ponied up \$60,000 to buy Lighthawk a turbocharged Cessna 210. Four years later Stewartt hired a second pilot, Bruce Gordon of Aspen, Colorado, and raised the funds to buy a second 210. Lighthawk now has an office in an old house in Santa Fe, an ad-

Jim Brandenburg/West Light



Grizzlies, wolves, and other wildlife are monitored via Lighthawk, dubbed "the Sky Tripod."

ministrative assistant, and an annual budget of \$130,000—a tiny sum for an aviation service but a respectable amount for a conservation organization.

Gordon, a 42-year-old mountain climber and teacher, signed on as Lighthawk's second pilot for \$16,000 a year. "Lighthawk combines all my loves," Gordon explains. "Flying, the mountains, my concern for the world, and my attempt to educate people on how perfect it is." His interest is pragmatic as well. "I see the whole environmental movement changing," he says. "We can no longer be a bunch of hip-



For Bruce Gordon (right), Lighthawk has packaged aviation and wilderness into the perfect job.

pies—we have to fight these battles in a business-like manner. Airplanes are a logical extension. Government and industry have been using them for years while conservationists have been stranded on the ground."

Conservationists are ground-bound no longer, but even with the two Cessnas each flying 400 hours a year, the demand for Lighthawk's services far outstrips its capabilities. The client list reads like a Who's Who of the conservation community: the Nature Conservancy, National Wildlife Federation, Sierra Club, National Geographic Society,

and the Wilderness Society, to name just a few.

Wildlife researchers are among Lighthawk's biggest fans. Since 1982, Bob Ream, a wildlife professor at the University of Montana in Missoula, has been monitoring the movements of timber wolves in the rugged area near Glacier National Park in northern Montana. He has enlisted Lighthawk to track radio-collared wolves and fly researchers into the study site. "Sometimes it's impossible to find the wolves on the ground," Ream explains. "You have to do it from the air, but usually it's extremely expensive. And we have a small budget." Although the 210's lowest safe speed, 75 mph, is a tad fast for tracking, Ream still managed to find one of his collared wolves above the Canadian border, an extraordinary 30-mile one-day trek from the wolf's normal range. "Without Lighthawk, we might have missed that movement altogether," he says. In fact, Lighthawk has completely sold Ream on the airplane as a research tool: he's now taking flying lessons. Ream is also building a Falcon XT airplane from a kit. He hopes that one day soon he'll be doing his own flying to the study site's grass airstrip, located in Moose City, Montana.

When it comes to Lighthawk's more politically freighted missions, Stewartt is quick to point out that Lighthawk is



The pilots occasionally find time for a close-up view of what they normally see only from several thousand feet.

not opposed to development; rather, it is dedicated to giving people a voice in the inevitable development of the West. Still, Stewartt is the last to back down from a fight when he feels that Lighthawk is clearly in the right. In 1984 Lighthawk starred in a campaign to force the Phelps-Dodge copper smelter in Douglas, Arizona, to comply with the Clean Air Act. The smelter, which had been operating under a waiver for 10 years, was the nation's largest single source of sulfur dioxide emissions, a major component of acid rain. Lighthawk flew environmental lawyers to meetings, carried doctors to Environmental Protection Agency hearings to testify on their patients' respiratory problems, took state officials above the plant to persuade them to join the lawsuit, and gave TV camera crews a bird's-eye view of the 100-mile-long noxious yellow plume. "We just flew our butts off," Stewartt says.

The effort paid off. Last year the EPA ordered Phelps-Dodge to comply with the law, forcing closure of the plant. Residents who had fought the smelter were lavish in their praise of Lighthawk, citing its efforts as a major factor in their success.

Despite rave reviews, Lighthawk still must scrounge for funding while struggling to meet the growing demands of its clients. Stewartt talks of adding a twin-engine turboprop aircraft to ferry groups to meetings, a Latin American Lighthawk to help fight global deforestation, and one more pilot. Closer to home, Stewartt hopes to create a network of volunteer pilots across the West—a Lighthawk air force.

Stewartt has also become increasingly aware of the drawbacks of his success. He worries that after devoting all his energy to raising funds, contacting the media, and running Lighthawk, he is losing touch with the land that inspired

him. So he recently took a few weeks off to hike the slickrock and sage he usually sees only from thousands of feet up.

Back on the job at 6,000 feet over Canyonlands National Park in eastern Utah, Stewartt points out the Colorado River snaking through brick-red sandstone formations, the turquoise settling ponds of a potash mine, mesa-top pot-holes spangling from an afternoon shower. Suddenly he points up and left: a golden eagle hovers a few hundred yards away, flying in perfect formation with the Cessna. "Whew! Damn! Did you see that?" As the eagle banks away unperturbed, Stewartt grins. "That's twice in two weeks!" For a lighthawk, flying with the eagles is all in a day's work. —

Off on another patrol, Stewartt foresees a Lighthawk air force of volunteers across the West.



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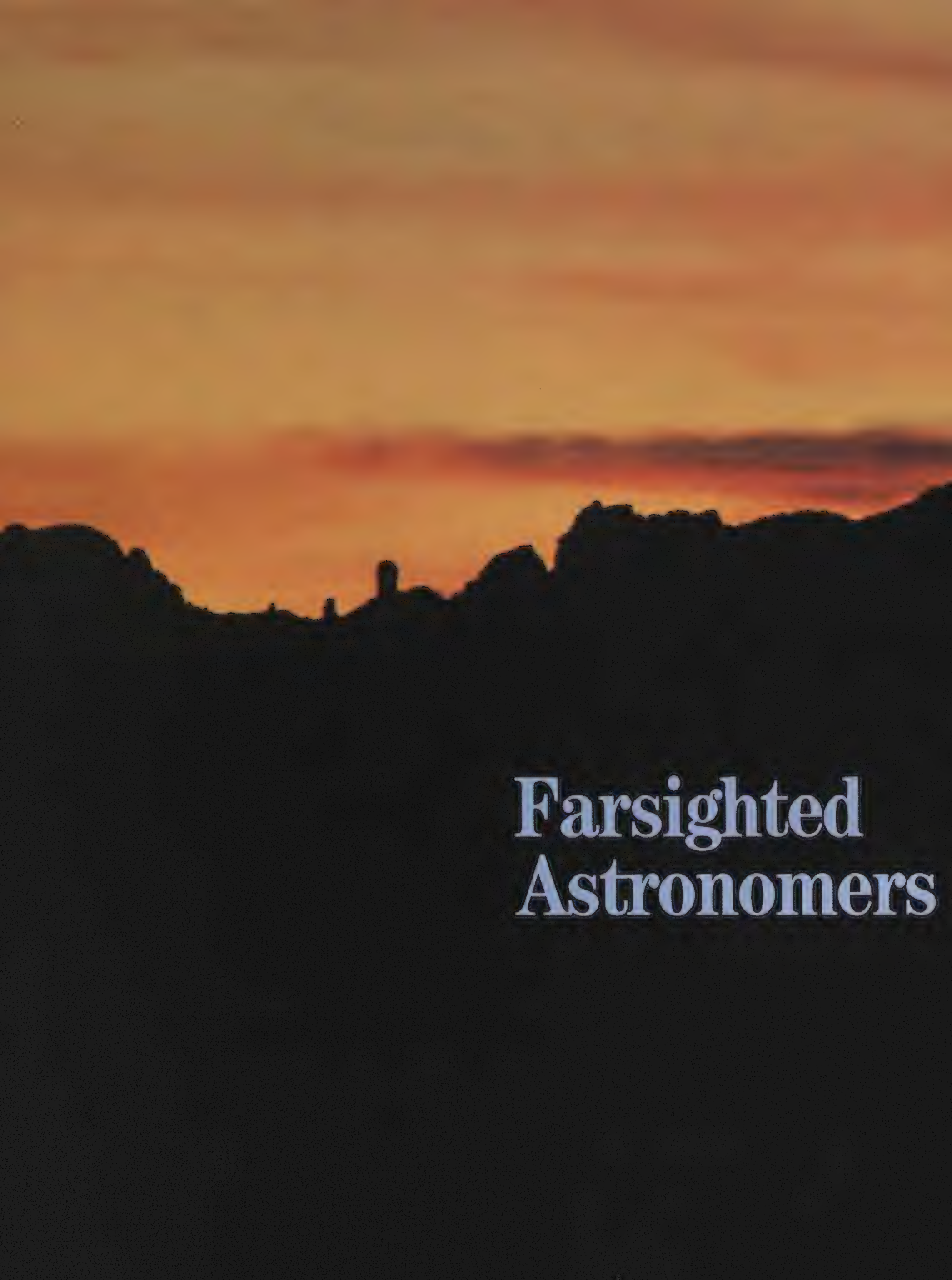
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Farsighted Astronomers

**They're on top of the world,
looking back on creation.**

by Marcia Bartusiak



For Stanislaw Djorgovski's quest, clear skies aren't enough; he also needs a roomful of electronic gadgetry.

“We can get a bit grouchy if bad weather sets in,” confesses Stanislav Djorgovski, peering anxiously out a window of the dining hall atop Kitt Peak, a massive and furrowed wad of earth that sits on a desert plain in southern Arizona. From the mile-high mountaintop, the surrounding countryside, brown and nearly barren, appears as desolate as a lunar landscape.

Djorgovski, known as George to his co-workers at the Harvard-Smithsonian Center for Astrophys-

ics in Cambridge, Massachusetts, has traveled more than 2,000 miles to observe the heavens from this famous perch, the world's largest complex for extragalactic, stellar, solar, and planetary research and an astronomical mecca for observers from around the globe. Using the giant Mayall telescope—one of the world's largest with its four-meter-wide mirror—Djorgovski and Patrick McCarthy, a colleague from the University of California at Berkeley, are about to spend three nights on the moun-

Photographs by Jim Richardson

tain photographing young galaxies situated in remote regions of the universe. Since light travels at a finite speed, about 186,000 miles per second, the farther away an object is, the longer its light takes to reach earthbound telescopes. Thus, when astronomers look out to the most distant reaches of the cosmos, they are in effect traveling into the past. The most farsighted of cosmic explorers, they are searching for that ancient epoch when galaxies first coalesced out of the primeval soup.

When Halley's comet streaked by Earth in late 1985, Kitt Peak was plagued by snowstorms. A year later, during Djorgovski's observing run, only a smattering of snow lurks in the mountain's crevices. Djorgovski's gamble has paid off. Applying for telescope time months in advance, as is required by observatory administrators, he could only hope that nature would be benevolent; observatories do not hand out rain checks. But as the setting sun paints the nearly cloudless western sky a vivid orange, spirits soar. "It's sure to be a good night," declares Djorgovski as he and McCarthy head up to "the Big Four" in one of the observatory's battered white pickup trucks.

They will put in their hours tonight not glued to the telescope's eyepiece but seated in a narrow room off to one side of the telescope. This area, with its glimmering array of clocks, gauges, and electronic paraphernalia, looks much like the control center for a spacecraft mission.

Above the telescope operator's L-shaped console, a pair of windows overlooks the giant reflector. Its broad mirror is mounted in a colossal blue prong. But now the window shades are pulled tight: the objects Djorgovski and McCarthy seek are so faint that any stray light could ruin the observation.

Ensnared in comfortable lounge chairs, the two astronomers spend most of the night in front of a computer monitor, either entering or checking the innumerable bits of data required for each observation, such as the desired filter or the position of the focus. "We've gotten spoiled by the new technologies," says Djorgovski. One of these is the charge-coupled device, or CCD. Astronomers have begun replacing cumbersome and inefficient photographic plates with

these ultrathin, stamp-sized silicon wafers. Photons of light entering the telescope strike the chip's surface and are converted into electrons, which get stored in electronic wells at the point of impact. Hundreds of thousands of these wells form a grid-like pattern, much like the dots, or pixels, that make up a satellite-transmitted photograph, over the CCD. The charges in all the wells are measured periodically by a computer, which swiftly converts this information to an image that can be studied and stored.

Djorgovski and McCarthy choose to examine their images as if the pictures were negatives: the stars and galaxies appear on a graphics terminal as dark specks against a light background.

Collecting data from the edge of the visible universe requires the use of the world's largest and most sophisticated telescopes, which are few in number; observatories receive many more requests for instrument time than they can accommodate. Only a small coterie of astronomers can hope to devote their life's work to the study of the universe's outermost boundaries.

The searches conducted by Djorgovski and McCarthy are part of a celebrated program initiated by Hyron Spinrad at Berkeley about 15 years ago. "Hy is just as much an artist as he is a scientist," says Djorgovski, a Yugoslav who first came to this country eight years ago and studied under Spinrad. "Hy's been known to spend as much as 30 hours of telescope time to figure out the distance to one far-off galaxy. I would have given up, but not Hy."

Spinrad likes to compare his endeavors to those of a pole vaulter. "Every year," he says, "we raise the bar a little higher."

The challenge escalates too. The deeper astronomers peer into space, the more they must strain their telescopic eyes. Galaxies appear dimmer, smaller, and fuzzier. Twenty years ago, astronomers were lucky if they could examine galaxies one billion light-years away. Today, thanks largely to CCD technology, observers are regularly detecting galaxies out to eight billion light-years and beyond, more than halfway back to creation.

Spinrad's ultimate goal? "The very beginning," he responds. "Of course,

the word 'beginning' means different things to different people. What I mean is the beginning of the universe's major constituents—the galaxies."

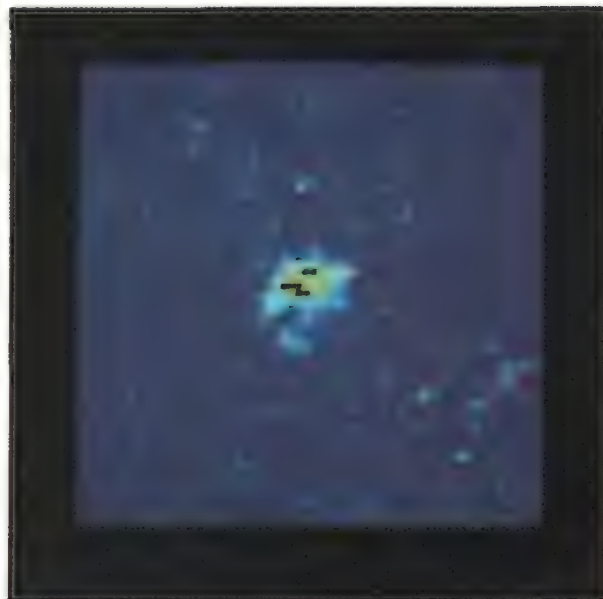
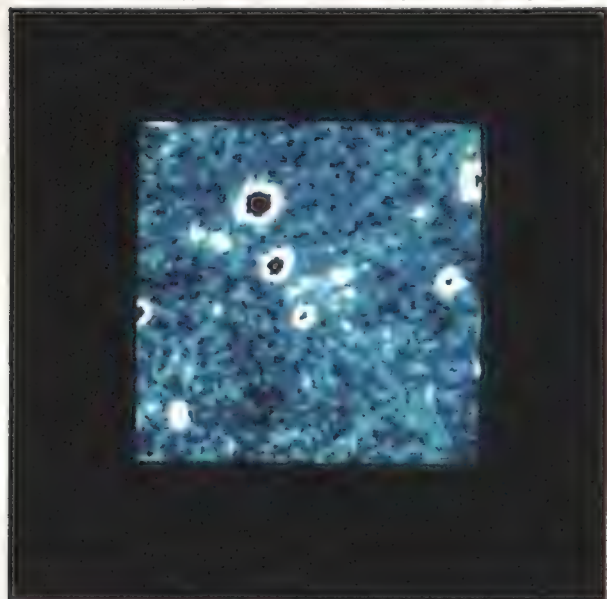
Each galaxy is a celestial island composed of tens of billions of stars. Astronomers believe that these galactic lumps congealed from the ocean of particles spawned in the primordial explosion, playfully dubbed the Big Bang, which occurred some 15 billion years ago. The



Kitt Peak's four-meter Mayall telescope allows astronomers to peer halfway back to the Big Bang.



Patrick J. McCarthy/Leuschner Observatory, UC Berkeley (2)

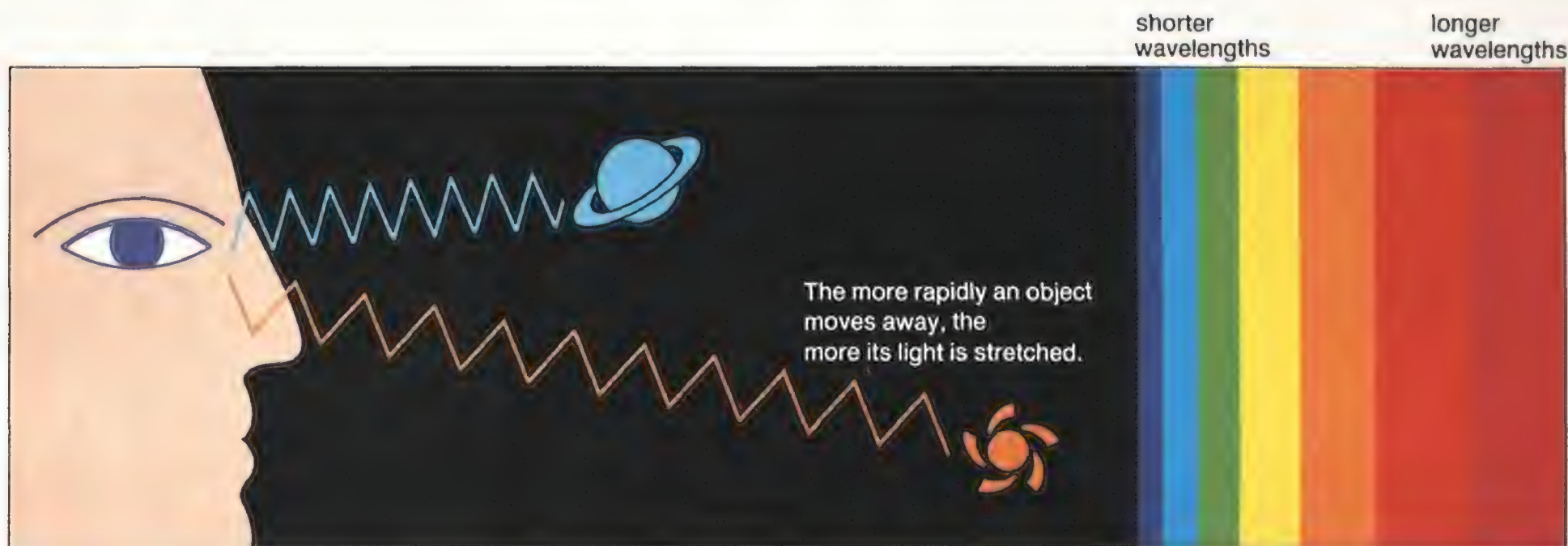


Patrick McCarthy won astronomical kudos for his study of the gas cloud surrounding radio source 3C 326.1. The far left photograph shows all visible light around the radio source. The near left photograph was taken through a special filter that admits only photons from ionized hydrogen that have the same redshift as 3C 326.1. The concentrated hydrogen may herald the birth of a galaxy.

Distant objects move away from us more quickly than nearby ones, so they appear redder.



The observing duo won't know until weeks of analysis are complete whether they've hit celestial paydirt tonight.



entire universe continues to expand, and galaxies go along for the ride.

To gauge a galaxy's distance, astronomers measure how much its light has reddened, or "redshifted," as the galaxy is carried away. The more distant a galaxy, the more quickly it moves away from us, and therefore the more the lightwaves traveling from it to us are "stretched"—made redder.

Spinrad's group finds many of its distant specimens with the help of radio-astronomy surveys. The far galaxies they seek emit intense radio waves from their centers. "The radio signal tells us where to point the telescope, or else we'd never find them," explains Spinrad. "About a third of our sources turn out to be washouts. Sometimes they're close by; sometimes we never find out what they are. But then we try again, sinking our teeth into these things like bulldogs."

The hunt continues at Kitt Peak. "We're going to try to image a few more distant galaxies tonight," says Djorgovski.

"But we could put many hours in," warns McCarthy, "and get nothing."

As the strains of a classical symphony emanate from a portable radio, telescope operator Dave Chamberlin types a series of commands into his terminal, which directs the telescope to the coordinates of an unseen, radio-emitting object labeled 3C 194 in the Third Cambridge catalog of strong radio sources.

Three pictures are taken: one with a blue filter, one each in red and yellow. Each exposure takes 10 minutes. What later appears on the graphics screen, amid a sprinkling of foreground stars and nearby galaxies, is a dim, elongated

fuzz. "We're finding that a lot of these very distant galaxies are hot dog-shaped," explains McCarthy. The Milky Way and most contemporary galaxies are either spiral or elliptical, configurations that astronomers consider more stable than the oblongs McCarthy studies. "They haven't settled down to the more quiescent stage we see around us today. It's possible that they're colliding or somehow interacting with some gas-rich neighbors," McCarthy suggests. Or perhaps, as Spinrad has proposed, these young galaxies are actually forming out of smaller, stellar units.

Only a couple of decades ago, such theories would have been considered preposterous. "When I was a kid," recalls Spinrad, "galaxies were separate, like the continents. But now we know that the continents haven't always been separate. The same may be true of galaxies." Astronomers are realizing that galaxies can be intimately involved with their neighbors—merging, swapping mass, and triggering stupendous bursts of star formation in one another. Perhaps such activity was even more prevalent eons ago.

At nine o'clock, the telescope is aimed in the direction of the constellation Cetus, the Whale. A low-pitched rumble fills the air as the massive dome moves into position overhead.

A few years ago, while trying out "the type of procedure that telescope committees aren't anxious to give time for," he says, Djorgovski uncovered the farthest "normal" galaxy on record; it resides some 11 billion light-years from Earth. (Quasars, the abnormally brilliant cores of distant galaxies, can be seen farther, but the full bodies of these

galaxies cannot be discerned.) He did this by pointing the telescope toward a bright, far-off quasar—an object whose redshift is known—and combing its vicinity for hidden neighbors. He figured that the quasar's companions, if any, might come into view when a filter was installed that would admit light that shared the quasar's redshift. "To use a musical analogy, the filter enables us to listen to one tone amidst a cacophony of noise," explains Djorgovski.

Djorgovski employs this strategy tonight, looking at a quasar in Cetus. After a 21-minute exposure, the CCD picture displays a distinct smudge to the east of the quasar. "A solid maybe," says Djorgovski. "Sometimes we can get blasé over the fact this blob on the screen may be three times older than our solar system." Surety will come as soon as a spectrum, a breakdown of the smudge's composite wavelengths of light, reveals the object's redshift.

At ten o'clock, Djorgovski and McCarthy, bundled up against a winter breeze, take a brief stroll on the catwalk that wraps around the middle of the 19-story-high dome. It's an opportunity to remind themselves that the glowing dots displayed on their TV monitors have a reality outside the control room. The Milky Way, the vast array of stars that mark the spiralling disk of our own galaxy, appears as a misty cloud stretching from horizon to horizon.

Returning to work, the two colleagues unmask what may be another distant galaxy. A quasar labeled S4063+68 has a suspicious companion, too. "Be still my foolish heart," quips Djorgovski with a mischievous grin, as he looks at a filament connecting the

point-like quasar with a softer blob. "Curiouser and curiouser," he says, leaning into the screen. "We've earned our salary tonight."

By three o'clock in the morning, though, their luck has run out. High cirrus clouds have drifted in, disrupting the view. McCarthy, working on his doctoral thesis, was hoping to photograph intriguing fountains of gas being ejected from some of the far-off galaxies. But the Berkeley student has already learned that patience is *de rigueur* in this specialty, along with confidence, dogged persistence, and, at times, a bit of arrogance.

"It's an exciting time for us," notes McCarthy, "because the advanced instrumentation is enabling us to do more than just locate these far, primitive galaxies. We can begin to study their environments as well."

In 1986 McCarthy and several colleagues traced an enormous cloud of energized gas—three times the size of our Milky Way—around a radio source known as 3C 326.1, situated some 10 billion light-years from Earth. It's McCarthy's most notable achievement to date: the cloud, which has the mass of 100 billion suns, is emitting a relatively small amount of starlight, compared with the brightness of the gas, which suggests that it might be a galaxy in the throes of birth, a late-blooming protogalaxy undergoing its first, turbulent bursts of star formation—"what astronomers have been seeking for decades," says McCarthy.

Spinrad concedes that there is a potential pitfall in these efforts. The remote, radio wave-emitting galaxies that his team surveys might not be truly representative of what's going on at the far frontier. Other farsighted astronomers, including Alan Dressler of the Mount Wilson and Las Campanas Observa-

tories, administered from Pasadena, California, and James Gunn of Princeton, search for more ordinary specimens, each a sort of galactic man-in-the-street.

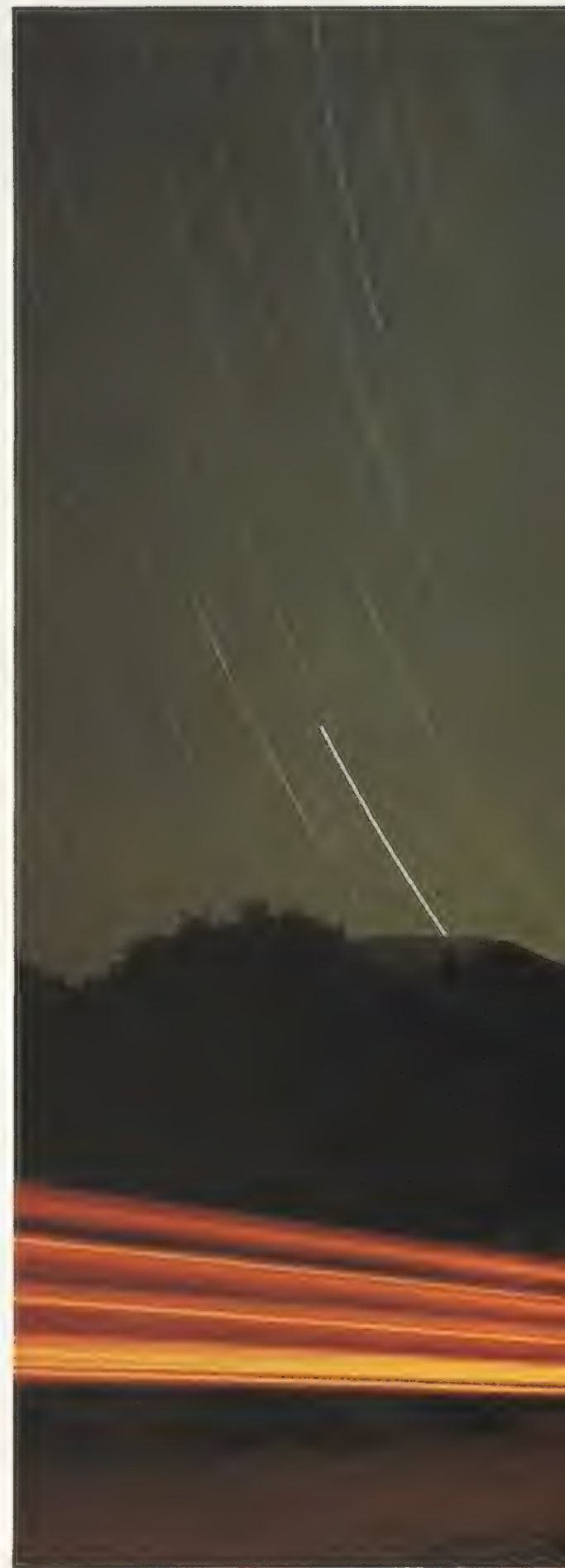
"What did galaxies, like the sedate Milky Way, look like five billion years ago? Ten billion years ago?" asks Dressler. "To find out, we must scoop out a section of space, as if we had a steam shovel, catalog all the galaxies in that region, then scoop out another section farther out and compare." In this way, Dressler and his cohorts hope to discern how galaxies evolved.

Since 1980, Dressler and Gunn have spent more than 50 nights on Palomar mountain in Southern California using the famous five-meter Hale telescope to examine distant clusters of galaxies. They have perceived exciting new facets of the universe's personality. "There's much more activity than we supposed ten years ago," says Dressler.

"Young galaxies do look more 'wild' than their older colleagues," says Gunn. "Today, we may be settling down to a senile old age."

Less than an hour before dawn, Djorgovski and McCarthy, fueled by a never-ending supply of coffee, manage to squeeze in one more observation. It's their 15th target of the night. With no time to spare, they take a blind exposure, not sure if their candidate—one of McCarthy's gas-spewing galaxies—is in the telescope's field of view. The first image displayed on the CCD monitor shows nothing of interest, and McCarthy looks disappointed. But when the picture is scrolled to reveal what was previously offscreen, McCarthy hits the jackpot: he sees a long spray of material shooting out from his target galaxy.

As the first rays of sunlight strike the stark white dome of the Mayall telescope, 12 hours of observing come to an



end. "On a scale of 1 to 10, I'd give this night an 8.5," concludes Djorgovski.

"Most nights," says McCarthy, "we usually average less than 5."

But their work has only started. After two more nights on the mountain—one extremely productive, the other spoiled by bad weather—the two astronomers travel back to their respective institutions, computer tapes in hand, to analyze their haul. "A lot of processing has



to be done before we even get to the science,” says McCarthy.

Still, ever so slowly, each and every pixel will add to an overall tapestry that astronomers have been weaving for centuries, a cosmic portrait that depicts a magnificent and ever-evolving story of creation.

Says Djorgovski: “It’s a challenge. It’s fun. It’s disorderly. It’s the best job in the world.” —

The Kitt Peak facilities stand near the figurative center of the universe for farsighted astronomers.

At the National Transportation Safety Board in Washington, there is a red telephone. This is what happens when it rings.

The Go Team

Herb Goro



Herb "Bad News" Banks earns his nickname every time he sets the NTSB wheels in motion.

by William Triplett

The first two days are critical because the evidence is fresh, undisturbed. Once people have sifted through the wreckage—"kicked tin," as the inspectors say—the clues begin to disappear. An airspeed indicator's needle may be moved. A fuel line may drain. Subtle clues are lost that could have revealed what caused an airplane to fail the people who rode in it.

So air crash sites are protected from the untrained until a remarkable group of specialists arrives to ply its somber trade. The group is called a Go Team, and it is staffed by up to 10 air safety investigators from the National Transportation Safety Board whose job demands the combined skills of detective, engineer, and trail scout. On 24-hour call, they respond whenever a serious accident occurs.

Go Team duty is rotated: immediately after one team has been dispatched, a new list is posted. If your name appears on the list, you're never without your electronic paging device, and you keep a suitcase half-packed at home. "You never know what climate you might be going to," says investigator Bud Donner, "so you pack only some basics and keep the heavy or light clothing nearby."

They could be in the middle of anything when they get a call. Ron Schleede, a former investigator who moved up to head the NTSB's aviation accident investigation division, recalls watching President Reagan's first inaugural parade come down Pennsylvania

Avenue when his beeper went off. And one investigator was vacationing on a California beach with his family when the NTSB came looking for him. He wasn't even on the list, but the team required his expertise. "If they need you," says Jim Danaher, a 16-year veteran, "they'll come get you."

Like firemen, Go Team members while away the hours with office work until the inevitable call comes in. The Federal Aviation Administration usually gets the first word of an accident, then calls Herb W. R. Banks, director of the NTSB's bureau of field operations. A red phone rings in Banks' office, and after he's gotten the location and nature of the accident, he notifies the Go Team, the board member on duty, NTSB chairman James E. Burnett, and the public affairs office. At night, Banks takes the call at home and relays the word. His phone calls have earned him the nickname "Bad News Banks."

The team will be on its way within two hours. Until they arrive, an investigator from the nearest NTSB field of-

fice will have secured the crash area with the help of local authorities. Representatives from the aircraft manufacturer, the airline, the engine manufacturer, and the FAA will also arrive. If it's a major accident, a member of the board will accompany the team. The investigator-in-charge calls a meeting and assigns each of these individuals to a section of the Go Team.

Now things begin to happen quickly. Investigators perform a once-over at the scene to see if the entire airplane made it to the crash. A missing wing or tail is obvious, but other signs are more subtle and easily lost if the site is disturbed. Once, Banks was sent to find out why a small airplane had broken up in flight. In-flight breakups can be particularly difficult to investigate because wreckage is usually strewn over a wide area. Banks' heart sank when he arrived to find a group of local authorities standing proudly by a neat stack of parts they'd gathered. Fortunately, it turned out they'd also marked the ground where they found the pieces.

Witnesses are identified, but at this stage their observations are simply documented, even if they are contradictory. In 1982, when an Air Florida flight struck a bridge after takeoff from Washington, D.C., investigators found two witnesses who'd been standing together

Go Teams leave Washington, D.C., and head for the airport within two hours of Banks' call.



when they happened to watch the airliner take off. Both claimed they could point to the precise spot from which the airplane had lifted off the runway—an important clue. The investigators stood them side by side at the spot where they said they had seen the jet, then asked them to point on the count of three to the spot where it had broken ground. One, two, three . . . both pointed simultaneously—in different directions.

In most cases, a local coroner performs autopsies on the flight crew to determine at the outset whether pilot incapacitation may have been a factor. An autopsy can also reveal who was sitting where in the cockpit and who was flying the aircraft.

After the preliminary steps are completed, the detailed work begins. The Go Team is organized into sections, each of which focuses on specific aspects of the investigation: power plants, structures, operations, survival factors, systems, weather, and air traffic control. Each section determines if the function within its specialty was operating or operable at the time of trouble or impact. Using their combined knowledge of flying in general and of this aircraft in particular, they compare what they know with what they find in the wreckage. Anything unusual can be a clue. Anything normal is equally important—it rules out possibilities.

Simple cameras are an important tool of the trade. Others include tape recorders, screwdrivers, wrenches, and pocket flashlights. Their modest load of equipment aside, the investigators are easy to pick out of a crowd because they're generally the ones wearing heavy boots, gloves, jumpsuits, and baseball caps with the board emblem or the letters NTSB.

Before they touch any of the wreckage, they take pictures of the scene from various angles and distances, talking all the while into their tape recorders. With its full complement of cameras and recorders, a Go Team at work can be an unsettling sight, like strange tourists in an even stranger land.

The power plant group is also responsible for determining whether an engine was developing power at impact and for examining thrust reversers, used in braking, and fuel systems. "We stop where the engine is bolted to the wing,"

says Paul Baker, a power plant specialist with 22 years' experience in engine manufacture.

Baker tasks his group with finding and identifying key parts. Such telltale signs as the position of the thrust reverser ballscrew can tell him if the reverser was deployed. The position of levers on the engine's fuel control system can help confirm the power settings. The twists and bends on a propeller indicate engine power at impact.

Now the investigators' expertise and experience come into play. They say every accident teaches them something new about how materials fail. They also say every accident occurs in some suggestive circumstance that guides the investigation. In August 1984, when a twin-engine airplane took off from Vieques Airport in Puerto Rico, rolled to the left, turned upside down, then crashed into the water, Baker first determined that the left engine had failed shortly after takeoff, which accounted for the roll. More importantly, the weather section told him that it had rained heavily for several days prior to the accident and that local pilots had complained about water in their fuel. Fuel samples taken from airplanes that had sat idle during the rains all had water in their fuel, so Baker had his probable cause for the engine failure. To nail it down, he had to check the fuel system

Pauline Lubens/Detroit Free Press

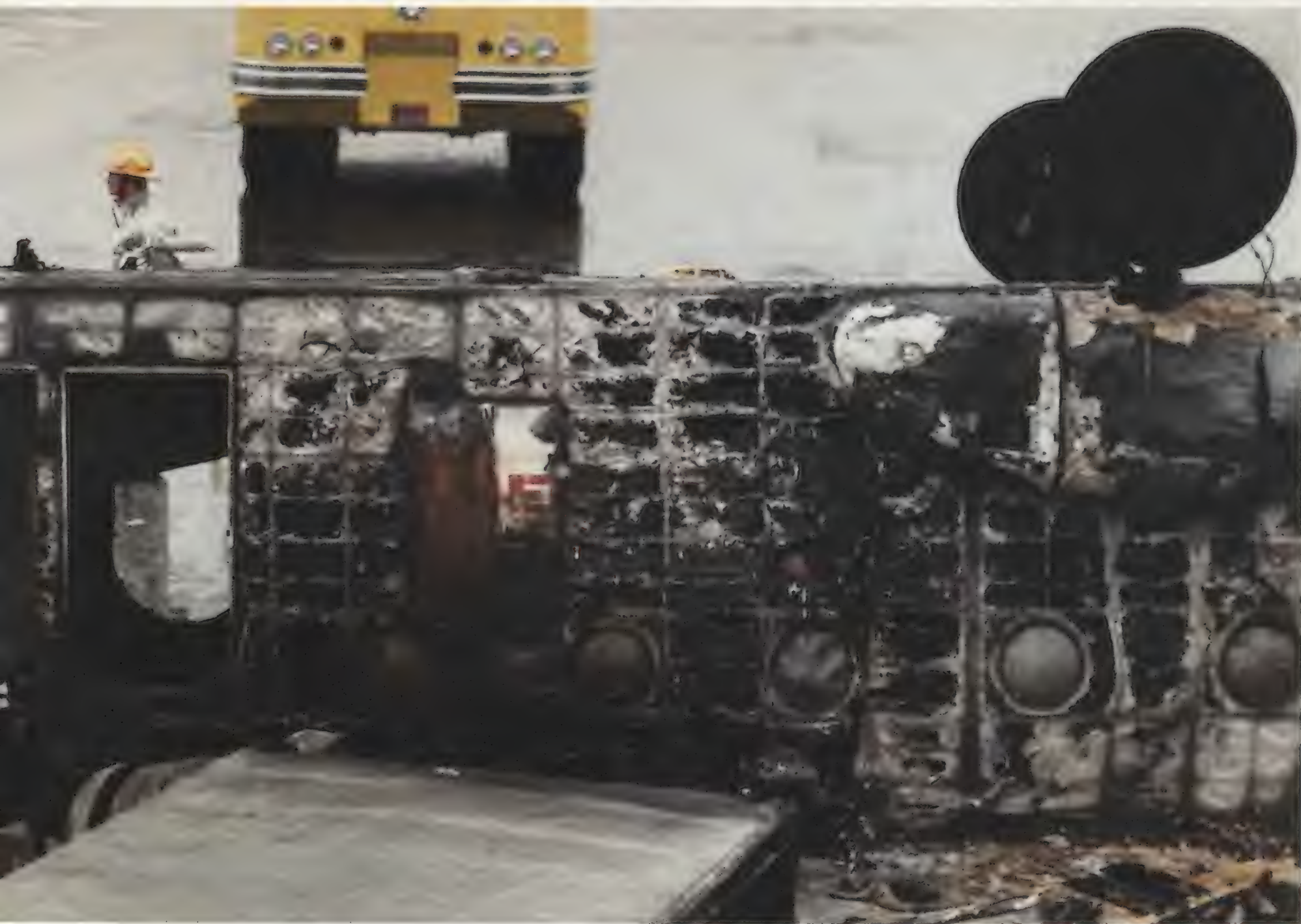


Herb Goro



The first reports from the accident are reviewed at a meeting to determine the team's lineup.

Last March, this commuter airliner crashed at Detroit's Metro Airport. A Go Team arrived that night (top).



of the wrecked plane, which had spent almost four days underwater before a salvage crew could haul it up. In addition to the expected saltwater, Baker found plenty of fresh water—in the left engine's fuel line.

John White has been a structures specialist for six years. A former flight test engineer with the Navy, White knows a great deal about fuselages, wings, tail sections, and their minutiae. He is responsible for locating and charting the "four corners of the aircraft"—the nose, tail, and right and left wings—at the scene, and determining whether a major structural failure occurred.

About five years ago, White investigated an accident in California involving a C-119 Flying Boxcar converted for use as a firefighting air tanker. A witness said the left wing had broken loose in flight. Starting from the point of impact, White walked back along the flight

path. After 15 minutes, he came upon a 20-foot section of the outer wing. Next he encountered pieces of the shattered inboard portion of the aileron, a control surface that forms part of the wing. On one piece, White noticed a discolored fracture on a metal bracket. Walking on, he found some bits of fabric from the broken aileron, and still farther, some flecks of paint.

A lab analysis told White that the bracket had corroded, accounting for its unusual appearance. He and other investigators concluded that the bracket had failed in flight, thereby allowing the small control-surface tab to which it was attached to vibrate in the wind. The inboard aileron had begun to flutter the way a flag does in the wind, and then it failed. The stress was too much for the outer wing, and it fell off.

Joel Ryan is a systems specialist who served 15 years as a field office investi-

gator before coming to Washington. He documents various aircraft systems, such as hydraulics, flight controls, and landing gear. Together with the operations specialist, he records their positions and readings as the cockpit instruments are located.

Cockpit documentation is done first in order to get to the instruments before anyone has handled them. The airspeed indicator, altimeter, and certain engine instruments usually retain their readings after impact.

Even a light bulb can speak volumes. "A hot filament shatters differently than a cold one," Ryan says, "so if you find that the landing light filaments were hot at impact, you know right away that at least the whole electrical system didn't fail." And Ryan swears by flap actuators. On an airliner, they're typically screw-and-bolt assemblies, and their positions tell whether the flaps were de-

Herb Goro



Heavy gloves offer some protection, but investigators still suffer cuts and bruises while probing a hulk.

After instruments are read and the position of key parts is noted, the wreckage can be moved indoors.

Herb Goro



ployed. Ryan admires the actuators' durability: "You can throw those guys against anything, and they just will not move."

Ryan carries an airplane systems manual with him to every scene. He flips to the page with the appropriate diagrams, then starts checking for systems continuity. He may start with cables and follow them to see if they lead to a suspicious point. He can tell whether a fire occurred before or after the crash by the way things burn.

Materials are the basic elements of accident investigations, but the human factor—the focus of an operations specialist—uncovers information of equal import. Bud Donner, a pilot for 30 years, came to NTSB as an operations

specialist and served on Go Teams in that capacity for three years before a recent promotion to investigator-in-charge. As an operations specialist, Donner's responsibilities included determining what the flight crew did in response to the emergency situation—how the pilots reacted and what results they got. Donner interviewed surviving crew members, and if there were no survivors, he concentrated on transcriptions from the cockpit voice recorder and flight data recorder.

Donner was on the Go Team that investigated the January 1985 crash of a Galaxy Airlines flight. The Lockheed Electra, a turboprop airliner, took off from Reno-Cannon Airport in Nevada and about a minute later requested clearance to return because of vibration. The tower controller granted the request, looked down to make a note to himself, and never saw the airplane again.

One of Donner's first discoveries was that the flight data recorder wasn't working, so the cockpit voice recorder tape became even more crucial. The power plant specialist determined from precise measurements of scrapes and gouges on the prop blades and other evidence that the engines were functioning at impact. All the controls, functions, and systems of the aircraft checked out, so the team was especially anxious to find out what the cockpit voice recorder would reveal.

The tape had picked up two odd thumps during takeoff, then a loud vibration the pilots couldn't identify. Subsequent investigation revealed that the vibration was probably caused by an improperly sealed access door on the right wing, but the pilots probably hadn't known that. The captain had responded by sharply cutting power to all four engines. The team could hear the power reduction on the tape, and suddenly, a violent rattle—the onset of a stall that caused the wings to lose lift. Twice the copilot had said, "A hundred knots," and then the pilot had said, "Pull up, pull up! Max power!" There the tape ended.

Donner knew the copilot's warning at 100 knots was meant to alert the captain that with the engines throttled back, the airplane was slowing to a speed dangerously close to a stall, which had been the immediate cause of the

crash. But the question remained: Why had the captain responded to the vibration with a power reduction that brought about the stall? Donner checked out Galaxy's pilot training program and found nothing to indicate why the pilot had responded as he had unless he hadn't seen the stall coming because the crew had been distracted by something. The investigation concluded that the wing door came open during takeoff, causing the initial vibration, and the pilot, unfamiliar with the wing door problem, probably reacted as he did because he had experienced a similar vibration in the past that responded favorably to a cut in power.

The survival factors specialist also examines the human element, but from a different perspective. Jim Danaher, a former Navy pilot now specializing in survival factors and human performance, will also interview survivors, though he will focus more on passengers than crew. If people evacuated, he'll want to know how they got out and whether the emergency equipment worked. If people died, he'll want to know how, particularly if others aboard survived. What took some lives but not others? A faulty door? A blocked path? Just luck?

To determine whether the crash itself or a defective piece of equipment was responsible for injury or fatality, Danaher consults lab analyses. Medical reports on passengers tell him a lot, as does paint. Danaher has often sent victims' clothing to the NTSB lab to determine if it contained paint from an object that may have struck somebody. The lab can identify an object from a paint sample.

While the specialists work on site, the NTSB's materials laboratory back in Washington performs the detailed analyses on pieces the specialists have sent in. James Wildey II, one of three metallurgists at the laboratory and a 12-year veteran, says that the majority of their time is spent looking at fracture surfaces.

They see two kinds of fractures most often: fatigue and overstress. Fatigue is distinguished by smooth, gradual waves of repeated cracks, often discolored. Overstress produces jagged, shiny marks that result from immediate trauma, such as a crash.





Eyewitness accounts are gathered immediately. Conflicting stories can be resolved later.

The investigation of the American Airlines DC-10 that lost its left engine after takeoff from Chicago's O'Hare Airport in May 1979 probably could never have been concluded without the help of the materials lab. Preliminary investigations led metallurgists to focus on the aft bulkhead of the left engine pylon—the vertical member on the wing from which the engine is suspended. They found the overstressed area where the engine broke off. As suspected, a trail of fatigue marks was also found leading up to the overstressed area. But the real mystery turned up when the metallurgists then followed

the fatigue marks to their point of origin, only to discover another overstressed area—and nothing else. The first overstress had caused the fatigue, and the fatigue had caused the final break, but what had caused the initial overstress?

The metallurgists and specialists reviewed the aircraft's maintenance records and found that when removing the engines, a maintenance crew had used a forklift to help lower the entire engine-pylon assembly. Although the crew didn't realize it at the time, the method was causing hidden damage at the points where the engine and pylon were fastened to the wing. As a result of the findings, the engine removal procedure was changed.

Each specialist focuses on his own responsibilities, but at the nightly meet-

Herb Goro



Herb Goro



A survivor can provide details that could not be obtained from wreckage or other witnesses.

Herb Goro



A jury-rigged surveying instrument helps a flight attendant describe what she saw from a parking lot (left).

At day's end, investigators gather in closed session to share newly gathered data and exchange ideas.

ings, the full picture begins to take shape as everyone shares the day's findings. Before the team retires for the day, often after an 18-hour stretch, the members will have gotten more ideas from one another about what to look for the following day. The on-site work usually lasts from 10 to 14 days; then the team returns to Washington to begin making sense of the findings and to write reports. Usually no sooner than nine months after the crash, a final report encompassing all the individual reports is released to the public.

Whether the accident involves a two-seat trainer or a 747, the team's procedures are the same. John White was part of the five-man NTSB team that participated in the investigation of the space shuttle *Challenger*, and the team looked at the evidence as it would have with any other aircraft. "The biggest thing to come out of our shuttle investigation was that the explosion did not destroy the *Challenger* as everyone had thought," says White. "We found far fewer burns and melts than we expected, and we discovered that aerodynamic forces broke the shuttle apart after the explosion."

For the Go Team, confronting death is part of the work, and every investigator must find a way to deal with it. Ron Schleede says, "You look but you don't see. Or try not to see." Bud Donner says of crash victims, "They don't even look like people anymore. You try not to think about it, and just go ahead with your work." They admit to getting hardened to it, but never used to it. Paul Baker vows that if he ever does get used to it, he'll get out.

But some accidents break through their defenses. Those around Christmas—with wrapped gifts strewn across the ground—get to Donner. Baker swallows hard at a teddy bear or a child's blanket. White has a harder time with smaller crashes than with bigger ones because, he says, "they're more personal. You almost get to know the people." And in the Arrow Air DC-8 that crashed after takeoff in Newfoundland, investigators found T-shirts reading "I Survived Gander, Newfoundland." That got to everyone.

They handle the tragedy by focusing ever more intently on finding the cause. When they succeed, they almost always

Herb Goro



Courtesy NTSB Laboratory



Courtesy NTSB Laboratory



feel rewarded. "If we can pin down what happened," says White, "then we feel we've made a contribution toward improving the safety of flying." Baker says, "If we can isolate maybe a trend or a recurring problem, it can lead to corrective action. That's a positive goal we all have."

The corrective action usually takes the form of NTSB recommendations made to the Federal Aviation Administration. The NTSB cannot legislate action, but according to spokesman Mike Benson, "About 87 percent of the recommendations made to the FAA were acted upon favorably in 1986." By the time the recommendations are made, the final investigation report is already written. But no case is ever officially closed. Regardless of how certain the investigators are of what happened,

Lab technician Spencer Phillips can magnify the tiniest fragments—here, a light bulb's broken filament—many thousands of times with a scanning electron microscope.

Herb Goro



Herb Goro



A charred but intact cockpit voice recorder; investigators count heavily on these "black boxes."

The expert eyes of metallurgy technicians analyze the violent forces that affected pieces from a tail.

their reports always conclude with the words "probable cause." Anything that qualifies as new evidence could relaunch an investigation anytime.

"We sometimes have reports that end 'cause unknown,' but we don't like it," Herb Banks says. "The mark of a good investigator is knowing when to stop. If you've turned up everything you possibly can and still have nothing, you've got to move on."

There are good reasons for their determination and meticulousness: attorneys will probably use their findings for reference, though the board's charter specifically prohibits the introduction of the final reports as documents in litigation. And implicit in everything they do is the hope that they can prevent the same "probable cause" from devastating any flight ever again. —

Law of the Next Frontier

Where humankind ventures,
can the rule of law be far behind?

by George S. Robinson

Legal historian Lawrence M. Friedman once observed: "[T]he law is a mirror held up against life. It is order; it is justice; it is also fear, insecurity, and emptiness; it is whatever results from the scheming, plotting and striving of people and groups, with and against each other"

Law—on Earth or in space—does not spring full grown into existence; it is a purely human creation, reflecting the needs and desires of its creators. In the past, law carried by explorers to new frontiers was frequently shaped by accountants, high-risk investors, kings and queens, and stay-at-home technocrats. It was often the law of money changers and missionary zealots.

The Space Age offers a chance to formulate a system of laws that can help break the endless cycles that have traditionally plagued civilizations: cultural parochialism, economic imperialism, colonialism, denial of basic human rights, and the subsequent violent confrontations that inevitably follow. As human beings spend more and more time beyond Earth's atmosphere, it is vital that we reflect on *how* we occupy and use space, not simply on the fact that technology has made it possible to do so. We must be sensitive to the need for principles of law and their underlying values so that space dwellers will have the necessary safeguards to live in space as our truly free envoys, carrying with them the best values our civilizations have to offer.

Already a well-polished mirror of law exists for unmanned activities in space; less well-polished is the law governing people in space, both now and in future space stations and settlements. Least polished of all is the law concerning self-government for space dwellers.

In 1958 President Eisenhower and the U.S. Congress established the National Aeronautics and Space Administration to lead a peaceful civilian exploration of space "for the benefit of all mankind." An enlightened step, it seemed a philosophical and political transcendence on a level with the League of Nations and the United Nations.

President Johnson later proposed to the United Nations that

the moon and other celestial bodies be explored only for peaceful purposes. "I am convinced," Johnson said, "that we should do what we can—not only for our generation, but for the future generations—to see to it that serious political conflicts do not arise as a result of space activities."

Like Presidents Eisenhower and Kennedy, Johnson feared that space activities would extend militarism beyond Earth's atmosphere unless space treaties included firm prohibitions against such expansion. The Soviet Union shared these concerns, and both nations made it clear that they did not consider their negotiating efforts in this matter to be simply treaty business as usual.

Almost 10 years after the creation of NASA, the United Nations Outer Space Treaty of 1967 articulated some elevated and unprecedented principles for international cooperation in this new *res communis*, or common property. The treaty led to several other practical agreements, covering subjects such as the international registration of spacecraft, accident liability, the international legal status of astronauts, the means for exploiting the moon and other space resources, and rules governing testing and using weapons in space.

The 1967 treaty stipulated that space would be the province of all mankind, with space exploration carried out for the benefit and in the interests of all countries, regardless of their levels of economic and scientific development. Space research would be consistent with international law and conducted in the interest of furthering international cooperation, understanding, and peace everywhere, on Earth as well as in space. Particular emphasis was given to the conviction that outer space must not be used for war. The treaty also recognized the special status of astronauts: "States . . . shall regard astronauts as envoys of mankind in outer space."

Although space law may appear at times to be a bewildering mosaic of both domestic and international laws, it still has the potential for establishing enduring values for humankind in space. This year's celebration of the bicentennial of the Con-

stitution offers an ideal opportunity to ask questions about the values the United States brings into space. What makes our country's movement into space more than just another cycle of economic and military imperialism? What is unique about what the United States has to offer humankind's movement off Earth? Perhaps it is, in the end, an ideology and some form of the governing structure outlined in the Constitution, a protective text of principles that emphasizes individual freedoms, rights, responsibilities, and dignity. If so, is it right and reasonable for the United States to extend those protective principles to its space dwellers?

To help focus on our space envoys' need for principles of social order, the Center for Democracy of Boston University and the Smithsonian Institution's National Air and Space Museum have brought together a number of leading scholars, including legal experts, Constitutional historians, legislators, biologists, psychologists, engineers, ethicists, and experts in conflict resolution, to formulate a "Declaration of First Principles for the Governance of Space Societies." A statement of conscience as well as law, the Declaration is intended to serve as a petition by U.S. citizens to their government that embraces a strong position regarding human rights for space inhabitants.

The delegates to the First Principles conference convened in December 1986 at the National Air and Space Museum and have been working on a draft Declaration of First Principles since. Not only will it stand on its own merits, but the text is also intended to serve as an educational tool that will help students and others focus on our Constitutional heritage.

The current version of the proposed declaration opens with a rather ecumenical preamble that proclaims: "On the occasion of the Bicentennial of the Constitution of the United States of America and in commemoration of its values, we

We must reflect on how we occupy and use space, not merely on the fact that we have the technology to do so.

citizens of the United States

Bearing witness to the exploration and inevitable settlement of outer space;

Recognizing the universal longing for peace, security, and liberty;

Reaffirming our faith in fundamental freedoms;

Expressing our unshakeable belief in the dignity of the individual, and mindful, as were our nation's founders, of the self-evident truth that we are endowed by our Creator with certain inalienable rights;

Urge acceptance of the following first Principles for the Governance of Space Societies."

These principles and underlying values are, for the most part, critical components of the constitutional charters of all

truly democratic societies, not just the United States. The values and principles may be modified by the interests of some nations and the physical realities of space habitation, but they need not—indeed, must not—be discarded altogether.

Some of the principles being formulated for the Declaration of First Principles reaffirm that the fundamental needs for life, individual freedom, liberty, justice, dignity, and the responsibilities inherent in self-determination are integral parts of humanity's exploration and settlement of space. The text also deals with such fundamental rights as freedom of speech, religion, association, and assembly; the right to petition and to own and dispose of property; and the right to provide for the common defense and the maintenance of essential public order.

The draft declaration also speaks of space dwellers' inalienable rights of informed consent, the need to diffuse advancements in science and technology for the benefit of all humankind, and the rights to reasonable personal privacy and to protection from cruel and unusual punishment.

Finally, the declaration embraces the fundamental principles of the United Nations charter, as well as existing international treaties to which the United States is a signatory, relating to human rights and the activities of states in outer space, on Earth's moon, and on other celestial bodies.

But principles are not enough: if there is truly any majesty in the law, it is reflected in the commitment of nations and peoples to support and defend the principles fully.

There are no shortcuts in establishing dynamic, organic, and diverse civilizations, no matter where they are located. The skeleton for a civilization depends upon community consensus, as well as an ideological and jurisprudential superstructure that reflects a commitment to survival and to the resolution of disputes by law, not force—in short, a law that protects the diversity and individuality of sentient creatures and their societies. It is our generation that must formulate the cultural matrix, the legal context, in which our envoys and their societies in space will be shaped and defined. How shall we rate as founding fathers and mothers?

The world today is haunted by forebodings of apocalypse—stories of nuclear winters, Star Wars, and Armageddon. Our fragile link to the future is in our own hands, and if we should fail to preserve and strengthen that link there may be no future of quality for human beings, either on Earth or in space. We must choose either to establish firm values for ourselves and our space envoys or to preside over the disintegration and loss of those values. "We are living," said Albert Einstein, "in a period of such great external and internal insecurity, and with such lack of firm objectives, that the mere confession of our convictions may be significant, even if these convictions . . . cannot be proven through logical deduction."

A well-conceived and drafted Declaration of First Principles for the Governance of Space Societies will serve as no mere confession of concerns and convictions. Rather, it can be a forceful call to focus attention on the absence of carefully crafted assertions of basic rights and freedoms for human beings in outer space. It is critical for our sons and daughters that we begin now to polish a mirror of law that will reflect our best cultural values in space . . . and on Earth. ➔



*I chose Kitty Hawk because it seemed the place
which most clearly met the required conditions.*

Wilbur Wright to his father, September 9, 1900

In October my brother and myself spent a vacation of several weeks at Kitty Hawk, North Carolina, experimenting with a soaring machine. We located on the bar which separates Albemarle Sound from the ocean. South of Kitty Hawk the bar is absolutely bare of vegetation and flat as a floor, from sound to ocean, for a distance of nearly five miles, except a sand hill one hundred and five ft. high which rises almost in its centre. The main slope of the hill is to the northeast, which is facing the prevailing winds. The slope is one in six ($9^{\circ} 28'$). To the north, northeast, east, and southeast there is nothing but flat plain and ocean for a thousand miles nearly. It is an ideal place for gliding experiments . . .

Wilbur Wright, in a letter to fellow aviator Octave Chanute,
November 16, 1900

by Charles E. Little

Appointment at Big Kill Devil Hill

One day, perhaps 15,000 years ago, perhaps a few millennia later, the Earth's oceans began, imperceptibly, to rise. The last of the Pleistocene's ice ages was over. As the climate warmed, the ice began to melt, raising the sea level higher and higher. Old coastlines disappeared and new ones were created. The mouths of the eastern rivers of North America crept westward, transforming broad inland valleys into complex systems of bluffs, marshes, and bays. Storm-driven tides carried sand coastward, creating high banks atop former beaches and enclosing vast, shallow impoundments behind them. As the waters continued to rise, these sand formations migrated inland, rolling over on themselves as they moved up the shallow seabed of the continental shelf.

And then, about 5,000 years ago, the water stopped rising, and the migrating islands slowed their pace.

Such is one way to begin this story. There is another. It involves not great geological events but a child's toy, a spinning helicopter-like device made of cork and bamboo. The toy, invented by Alphonse Penaud, a 19th century French aviation theorist, was manufactured by the thousands in Europe, and many were exported to the United States. In 1878 Bishop Milton Wright, the minister of a midwestern United Brethren congregation, bought one for his two youngest sons, Wilbur, 11, and Orville, 7. And the rest, you might say, is history. Twenty-five years later, the Wright brothers, brilliant self-taught engineers who had grown fascinated by the mechanics of what was then called an "aeroplane"—a surface that when properly presented to the wind would soar through the air—built the Wright *Flyer*, the craft that inaugurated the age of powered flight.

In fact, both these beginnings are necessary—one in geological time, the other in historical time. For the age of flight to have commenced as it did, a fateful rendezvous was required. An isolated and perfect sand dune had to be formed, about 100 feet high, a mile around at its base, surrounded by soft sand, with strong and steady autumnal winds striking its flanks. And then, somehow, two brothers in Dayton, Ohio, had to find out about this dune and travel a thousand miles to it to test a crucial innovation in "aeroplane" design—a mechanism to



warp a glider's wings—so they could determine whether a man could board a flying machine and reliably control it. This is the story of how this momentous meeting came about.

In the summer of 1899, Wilbur and Orville Wright were the successful proprietors of the Wright Cycle Company, manufacturers and purveyors of the new chain-driven "safety" bicycles. The Penaud helicopter toy was long gone, but it was not forgotten. The brothers had assiduously studied all the literature of aeronautics and were convinced that man could fly. Further, they believed they could build a heavier-than-air machine to permit safe flight over long distances. They worked out their theories with various models that they flew as kites, and in the process they became the world's foremost living theorists on aircraft design—though neither they nor the



shifty winds above the Pinnacles or the rough ground beneath. It was wonderful for vultures, not so good for engineers just learning what they called "the art of flying."

A few years earlier, Octave Chanute, a French-born engineer who had gained a worldwide reputation as an aeronautical theorist and experimenter, had given a series of well-publicized gliding demonstrations at the Indiana Dunes. These dunes, located on the Lake Michigan shore, were just a 90-minute train ride from Chicago and easily accessible from Dayton. So on the Monday after Thanksgiving in 1899, Wilbur sent a letter to the U.S. Weather Bureau in Washington, D.C., asking for the wind velocities for the Chicago area during August, September, October, and November—the end of bicycle season. The brothers were curious about conditions at the Indiana Dunes because they were interested in taking Chanute's work a step further. "We have been doing some experimenting with kites," Wilbur wrote by way of explanation, "with a view to constructing one capable of sustaining a

world were yet aware of it.

And so it was that 32-year-old Wilbur set out one day that summer for a river bluff near Dayton to perform what turned out to be a momentous test. He had been observing the flight of vultures over this place, called the Pinnacles, where updrafts kept the birds wheeling long enough for him to study how they turned on the long axes of their bodies—banking, we now call it—in order to change direction.

Training his binoculars on one vulture after another, Wilbur realized that a bird turns by making delicate adjustments to the feathers at the ends of its wings. When the vulture angled the left set upward and the right set down, its body would tip to the right, and this maneuver would cause the bird to turn to the right. To end the turn, the vulture would momentarily reverse the angle of its wingtips.

Wilbur and Orville decided to apply this idea to a biplane kite. To mimic the action of the vultures' feathers, they manipulated wires running from the kite's wingtips to hand-held control sticks to warp the wings. In a test at the Pinnacles, the device worked: with the wires, he could make the kite bank on command—and, equally important, if a sudden gust or shift in wind started to force the kite to turn, he could use the same technique to regain controlled, level flight.

Wing warping was not the only innovation the Wright brothers contributed to the emerging science of aeronautics, but at that point it was the most crucial. Earlier experimenters had determined that stationary wings could be made strong enough to carry a man aloft, that an airfoil could produce lift, and that an elevator could be devised to change the up-or-down attitude of a wing. But no one had yet figured out a practical, effective way to control the direction of a free glide. In 1896 the noted aviator Otto Lilienthal had demonstrated the need for this control by breaking his neck in Germany's Rhinower Hills when his bat-winged glider stalled and crashed. Previously, though, Lilienthal had achieved glides of over 1,000 feet, convincing the Wright brothers that if the control problem could be solved, heavier-than-air flight could be sustained over significant distances.

It was time for some serious testing of the control mechanisms, especially wing warping, and the relationship of these mechanisms to the design of the wing—its span, chord (width), and camber (its curvature in cross-section). Wilbur and Orville felt they had exhausted the utility of flying their model biplane as a kite: they were ready to try a man-carrying glider. But for this, neither brother was willing to trust the



man." They figured, based on Lilienthal's calculations of lift, that they needed a steady wind between 10 and 20 mph to test a wing-warping model glider—and Chanute's Indiana Dunes might be just the place to find it.

They did not have to wait long for an answer. In what may be the speediest response on record from a bureaucracy, the chief of the weather bureau, Willis L. Moore, sent the brothers a cordial answer dated December 4. Not only did Moore send the data requested for Chicago, he also sent copies of the bureau's *Monthly Weather Review*, which contained wind velocities at all 161 U.S. and Caribbean weather bureau stations. He put a check mark on the September table, just so Wilbur and Orville would not miss it. "Replying to your letter of the 27th ultimo," Moore wrote, "I have the honor to inform you that the Monthly Weather Review contains a table of average hourly wind velocities of all Weather Bureau stations.... I have indicated on the September Review the table above referred to."

Moore's tables prompted the Wrights to investigate areas other than "Chicago and vicinity." In May of the following year, Wilbur wrote to Octave Chanute, asking his opinion. Chanute wrote back suggesting locations in California and along the southern Atlantic coast—both places more remote than the Indiana Dunes, where his own experiments had been plagued by reporters and sightseers.

With Chanute's advice and the weather bureau list in hand, the brothers evaluated possible locations. One place, about two-thirds of the way down the first column of weather stations, had a curiously appropriate name for the young engineers: Kitty Hawk, North Carolina. Wind velocity was fairly constant all day, measuring 12.7 mph at 5:00 a.m., 13.8 at noon, and 13.4 at 7:00 p.m. The mean wind velocity was 13.4 mph for a 24-hour period in September, well within the parameters suggested by Lilienthal.

By this time, the great geological forces had done their work. At the end of the last ice age, a chain of narrow sand islands, the Outer Banks, had been formed off the coast of North Carolina. High dunes on the banks' ocean side protected an open sandy area on the leeward side. Here, a sturdy maritime forest emerged, and over the centuries its



For the present I have but little time for aeronautical investigations, in fact I try to keep my mind off this subject during the bicycle season as I find that business is neglected otherwise.

Wilbur Wright to Octave Chanute, June 1, 1900

Kitty-Hank, N.E. Post Office



This in my opinion would be a fine place; our winds are always steady, generally from 10 to 20 miles velocity per hour.... I assure you you will find a hospitable people when you come among us.

rotting leaves and branches provided nutrients that allowed a wide variety of plants and animals to flourish.

In time, the area provided sustenance to humans as well. The Algonquian Indians were the first to settle the region, though they established few permanent settlements there. It was the arrival of the Europeans, beginning in the late 1500s, that seriously altered the ecology of the fragile dune-islands all along the Outer Banks. Farms and villages sprang up. The new settlers cleared the forest for crops and set their domestic animals to graze, depleting the organic material that had held the unstable sand in place for centuries. Once again, the barrier beaches began a westward retreat from the unrelenting power of the Atlantic. Severe storms could now breach the barrier dunes, creating an overwash capable of carrying tremendous amounts of sand completely across an island.

One of the new settlements was given an Anglicized version of the Algonquian place name: "Chickahauk" became "Kitty Hawk." Four miles south of Kitty Hawk, a small stand of trees managed to remain. While storm-driven overwashes had leveled the dunes elsewhere, the lone remains of the dune forest held. Sand began piling around it, higher and higher, until it could grow no more: a hundred feet tall, more or less, a mile around at its base. It was called Big Kill Devil Hill, named, legend has it, after the "kill-devil rum" that floated ashore after a ship ran aground and was destroyed in the treacherous shallows off Currituck Banks.

The big dune was ready and waiting.

As winter turned to spring, Wright Cycle Company sales picked up. So it was not until August 1900 that Wilbur could get a letter off to Joseph Doshier at the Kitty Hawk weather station explaining the kite experiments they wished to make and asking about conditions on that part of the Outer Banks. Doshier's response was brief and unsatisfactory, but he passed Wilbur's letter along to William Tate, a leading citizen of Kitty Hawk and perhaps the only educated man in the village. Tate sent his own letter to the brothers. Like the letters from Moore and Chanute, this one was supportive and contained far more information than the Wrights had requested. "I would say," Tate wrote, "that you would find here nearly any type of ground you could wish. You could for instance get a stretch of sandy land 1 mile by five with a bare hill in center 80 feet high not a tree or bush any where to break the evenness of the wind current. This in my opinion would be a fine place; our winds are always steady, generally from 10 to 20 miles velocity per hour . . . I assure you," his letter concluded, "you will find a hospitable people when you come among us."

That did it. According to Fred Kelly, who worked directly with Orville on the Wrights' official 1944 biography, it was this letter that convinced the brothers, the "bare hill" being among the chief attractions. "Almost immediately," Kelly writes, "they decided they would go to Kitty Hawk as soon as they could build their glider." This they did in less than a fortnight, and at a cost of about \$15. With the glider disassembled and packed up, Wilbur set off on September 6, with Orville planning to follow as soon as he could get someone to take over the shop. Wilbur arrived on the sands of Kitty Hawk on September 13; Orville joined him two weeks later.

At last the stage was set. But what a close call it had been.



Had Willis Moore sent only the wind data for Chicago, the Wrights would never have heard of Kitty Hawk. Octave Chanute, a famous and busy man, found time to respond warmly to a scrawled letter from the proprietor of a bicycle company in a small Ohio city, suggesting that the Wrights investigate the southern Atlantic coast. And finally, had William Tate not responded with his detailed description of the landforms around Kitty Hawk, it is highly doubtful that the Wrights would ever have made the journey to what may have been the only place—Big Kill Devil Hill—where they could carry out their experiments successfully.

As it was, they *still* almost didn't get to the big dune that year. Once they arrived at Kitty Hawk, they chose to test their glider by flying it as a kite on some of the smaller dunes closer to the village.

During these tests the Wrights discovered that Lilienthal's lift data were wrong: it would take a stiff breeze, well over 20 mph, to send a man aloft in a glider with the lifting surface of



the machine they had brought with them. So they weighted it down with chains instead of men and did hundreds of experiments and calculations, working out equations to relate angle of incidence, wind velocity, gross weight of the craft, surface area of the wings, depth of chord, and airfoil configuration, among other factors.

Finally, toward the end of October—just a few days before they were to leave—Wilbur and Orville decided to lug their 20-foot machine, with Bill Tate's help, four miles down the island to Big Kill Devil Hill to see what would happen with a live body aboard. With the glider midway up the long steep slope, even a light wind might provide enough lift to test the craft's stability with a man at the controls.

A few tentative tries were made, then a full test. With Wilbur aboard lying prone and Orville and Tate running alongside, each holding a wingtip, the glider sailed into the wind, lifting itself through the magical physics of flight from the

surface of the earth. "You're off!" cried Orville and Tate.

The distance was 100 feet; airspeed, 30 mph. Wilbur, remembering Lilienthal's fate, promised not to go into a full soar. But unlike his predecessors, he had control, from the glider's front elevator and from levers at either hand attached to wires along each wing. The wires worked just like the ones controlling the kite he flew above the Pinnacles, warping the wings to correct for the wind and keep the craft level.

And so it was that Wilbur flew—*flew*—solid and steady down the big dune, coming to a soft, safe landing as the runners hissed across the sand. The appointment at Big Kill Devil Hill had been kept.

In all, the Wright glider and its pilot had spent three minutes



in the air. But at the end of the experiments of 1900, the brothers knew that the scientific principles they had discovered, as well as the means they had devised to exploit them, were on the mark.

Of course, the story goes on. In 1901 the brothers returned, this time going directly to Big Kill Devil Hill and setting up camp at its base. All that summer and the next, they perfected their glider, testing it again and again. The 1902 glider featured a rudder, which increased stability and control. During the winters, the Wrights worked on their wing design in a wind

tunnel they built in their bicycle shop. On December 17, 1903, they achieved their first powered flight, using a gasoline engine mounted on a slightly modified version of the 1902 glider. After this great success ("Inform press," they jubilantly telegraphed their father), the Wrights continued gliding and powered-flight experiments at Kitty Hawk until Wilbur's death of typhoid fever in 1912.

But was December 17, 1903, really the climactic moment, as historians claim? Or did it come three years earlier, when the Wrights proved to themselves, and eventually the world, how a heavier-than-air device could be reliably controlled? For this more elementary achievement, man's genius had to conjoin with the forces of nature that, beginning 15,000 years ago, slowly—and for all we know deliberately—created the perfect sand dune: Big Kill Devil Hill.

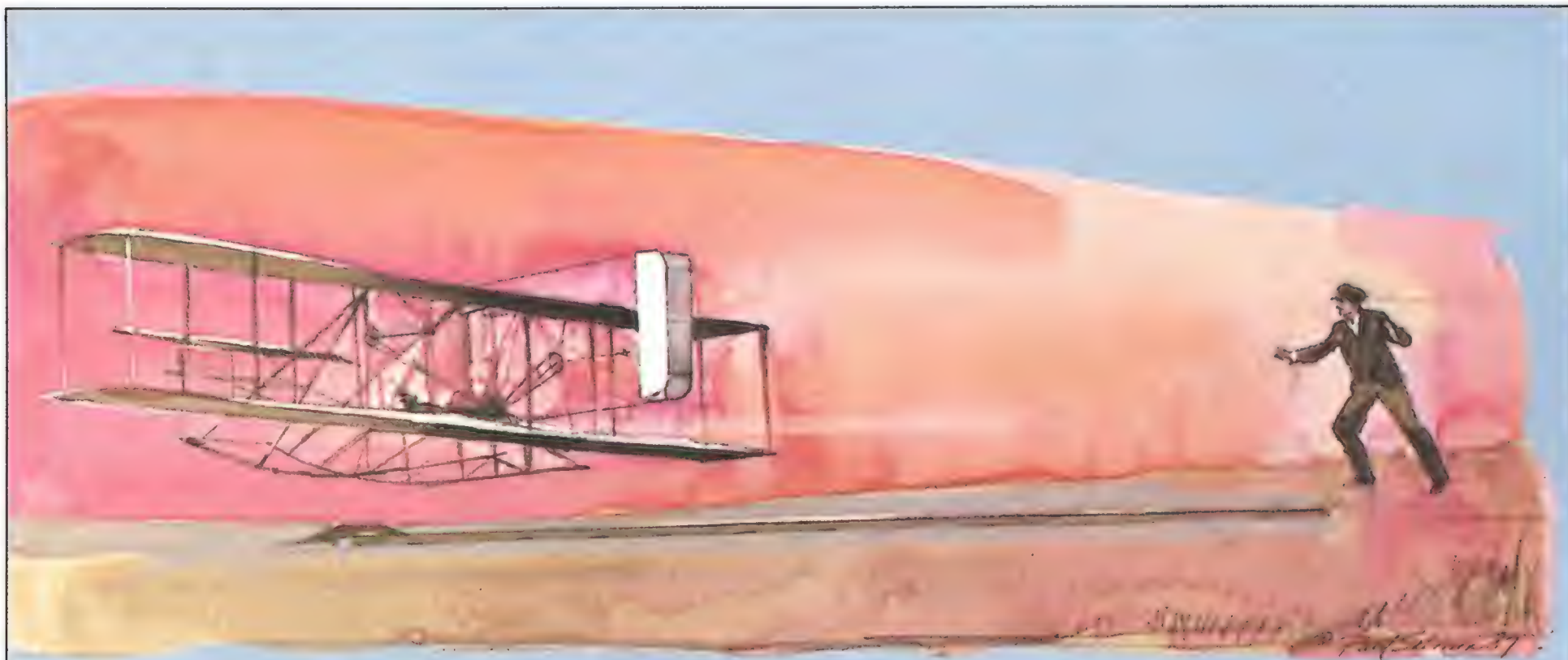
The dune is still there, of course. It is now surmounted by a monument to the Wright brothers in a 1930s modernist style that not all will find appealing. The sand is no longer soft, but it has been stabilized by exotic grasses planted by the National Park Service. No longer are there vast stretches of bare sand "from sound to ocean," as Wilbur had put it. This has become motel and condominium country.

Even so, you can stand on the big dune today, facing into the wind and looking out, as did Orville and Wilbur Wright, over ocean stretching "for a thousand miles nearly." The wind and sand and tide work ceaselessly to move the banks shoreward. Someday, the great hill will be gone. But it did its job, keeping its appointment with two brothers from Dayton, whose achievement is made of more solid stuff, and can never be eroded away. ➔

*We came down here for wind and sand,
and we have got them.*

Orville Wright at Kitty Hawk, October 18, 1900





Getting off the Fence

For Wilbur and Orville Wright, choosing an "airport" was the easy part. They still had to get their craft off the ground and into the air.

As Wilbur noted in a 1901 lecture to the Western Society of Engineers, "If you are looking for perfect safety, you will do well to sit on a fence and watch the birds; but if you really wish to learn, you must mount a machine and become acquainted with its tricks by actual trial."

Two Americans had already failed at manned launches. In 1894 expatriate Sir Hiram Maxim, who had made a fortune marketing a machine gun, spent \$200,000 assembling a 3.5-ton aircraft with over 4,000 square feet of wing surface and two 18-foot propellers powered by two 180-horsepower engines. For his runway, Maxim laid down a half-mile of wide-gauge railroad track at his estate in England.

On his first test flight, Maxim wanted to gain only a few inches of altitude, so he added a raised third rail, which was supposed to restrain his craft. But when he advanced the throttle, the powerful thrust lifted Maxim's aircraft completely off the tracks. The inventor hurriedly shut off his engines and ignominiously returned to earth. Walking away from his damaged airplane, Maxim announced that he had solved "propulsion and lifting." Mastering aviation, he added, would be "a mere matter of time." He never experimented again.

Next came Samuel Pierpont Langley,

a distinguished astronomer and Secretary of the Smithsonian Institution. In May 1896 Langley catapulted a 30-pound model, *Aerodrome Number 5*, off a houseboat on the Potomac River. This 80-second, 3,000-foot hop was the first successful sustained flight by an unmanned, heavier-than-air, self-propelled aircraft. *Aerodrome Number 6*, also unmanned, flew 4,200 feet six months later, coming down only because it ran out of fuel. When the United States went to war with Spain in 1898, the Army awarded Langley \$50,000 to build a manned airplane. He constructed a special engine that produced 52 horsepower yet weighed only 200 pounds.

After spending most of his money on the engine and complicated catapult launch equipment, however, the professor only had enough funds for two tests. Pilot Charles Manly never managed to get the craft into the air; he fell off the end of the houseboat on two occasions, in October and December 1903. Both times he was fished out of the Potomac, wet but unhurt. Langley blamed the catapult instead of his aircraft, but he was widely ridiculed for wasting public funds. In the wake of this experience, most government officials deemed manned flight impossible.

The Wright brothers proceeded differently. Wilbur and Orville understood that wing warping and other control techniques were far more important than brute horsepower. They weren't wealthy, so they relied on inexpensive devices to test their ideas.

Their construction and repair equipment at Kitty Hawk consisted of hand tools and a borrowed sewing machine.

Step by step and hour by hour, they learned to control gliders. In their fourth year at Kitty Hawk, the brothers were prepared. On December 17, 1903, only nine days after Langley's second failure, the Wrights succeeded.

Their 60-foot launching rail, dubbed Junction Railroad, consisted of four 15-foot two-by-fours set on edge and covered with a thin metal strip. The Wright *Flyer's* skids sat on the rail on a movable truck, which consisted of a long yoke laid across another plank attached to two small bicycle wheels. The truck slid down the rail, carrying the *Flyer* until the airplane picked up enough speed to leave the ground.

To move the craft from their camp to the takeoff position, the Wrights and their helpers slid the *Flyer* along Junction Railroad to its end, took the rear sections of track and placed them in front, then repeated the process.

After fellow aviator Octave Chanute visited Kitty Hawk, Wilbur wrote his father and sister on November 23, 1903, "Our track for starting the machine (total cost about \$4.00) amused Mr. Chanute considerably, as Langley is said to have spent nearly \$50,000.00 on his starting device which failed in the end to give a proper start, he claims."

Built cheaply but correctly, doing its job perfectly with no operating costs, the Junction Railroad was a fitting symbol of the Wrights' enterprise.

—Richard Sassaman

The World on \$52,200 a Day

by Michael Rozek

For travelers who've already toured the Antarctic and trekked to Tibet, the next logical trip is into space.

Paul Hudson/Society Expeditions



Riding a rocket, escaping gravity, and getting a spectacular eyeful of Earth—these are some of the lures of space tourism.

Some regret they never had the chance to become astronauts. Others like the idea of being able to say, "I was one of the first passengers to orbit the Earth in a spacecraft." For many, it's a love of adventure. And the few who have already seen most of the world yearn to view it from a new perspective. All of them share a powerful desire to visit space, and two years ago, a firm that made its name selling exotic tours put together a plan to help them get there.

In 1985, Society Expeditions announced Project Space Voyage, billing it as "the world's first public-access space program." Beginning in 1992, the Seattle travel firm plans to launch scheduled rocket flights that will orbit Earth from five to eight times and return. A ticket will cost \$52,200, and the trip should take from eight to 12 hours.

If all this seems a little speculative, consider the fact that 246 aspiring space tourists have already plunked down deposits of \$5,000. The youngest of them will be 18 in 1992; the oldest, 91. These people are serious. And they're not reluctant to talk about why they want to go.

Friends of Richard Headrick aren't at all surprised by his travel plans. "I'm one of those people who can't sit still," he drawls cheerfully. "I always want to be somewhere, doing something. In fact, on January 1, 1984, I sat down and drew up a list of goals for the rest of my life. First was to make my wife happy. But two and a half years ago, after 17 years, our marriage ended." Now the 44-year-old Laurel, Mississippi executive is pursuing his other goals. "Number two on my list is to make tons of money in my business so I can give it to the missionaries in South America." His sign company takes in \$10 million a year.

"I believe I'm doing God's will," says Headrick, who is a devout Baptist, "especially since He's been good to me financially, by trying to have as many interesting experiences as possible. I like to talk to people about Christ, but it helps if I have some other things to share with them."

Headrick's life-ordering list includes flying a floatplane and a helicopter, visiting the Arctic or Antarctic, and cleaning the hull of a supertanker (a dangerous diving job). He also wants to learn to tap dance.

It figures that Headrick would add a trip into space to his ambitious agenda. "I'm already a private pilot, so a friend of mine told me about the trip. I immediately sent in the money for two reservations" (he's counting on taking a companion along). He sees a space expedition as a way to fulfill both his love of adventure and his spiritual life. "Down here in Mississippi, we don't have clear evening skies, we can't go out at night and really see the heavens. But miles above the Earth, you not only can see them, but you're also that much closer to God. That feeling won't ever be matched until I get to Heaven."

The price of his ticket is no concern to Klaus Gachter, the 47-year-old co-owner of an air freight business near the San Francisco airport, "especially since it's five years away." He says he wants to orbit Earth because the one constant in his life is travel.

Gachter grew up in Switzerland, where at age 16 he decided to go into the travel business. "Switzerland is very secure and organized," he says, "but it can also be very claustrophobic. I thought being a travel agent would get me out of the country." He didn't leave until he was 23, when he got a job in the



Leroy Nordby: "If I have a personal philosophy, it's that I discover more and more of myself the more I get out and do the things I do . . . I want to go to space, and short of taking this trip, I don't know how else I'll ever do it."



Klaus Gachter: "You could say I like to satisfy my curiosity, or that I enjoy looking at and appreciating life In my lifetime, how many people will be able to go so far up and look down?"

California office of a Swiss air freight company. Eventually he started his own. "I spend maybe two months of the year traveling on business," he says, "often in the Middle East and South America." For pleasure, he's visited the headwaters of the Amazon River, the People's Republic of China, and the Tibetan side of the base of Mount Everest. "I guess I've been to most parts of the world except India."

But he's still stricken by wanderlust. And beyond bringing up his landlocked years in Switzerland, Gachter really can't explain why. "You could say I like to satisfy my curiosity," he allows, "or that I enjoy the benefits of looking at and appreciating life." It's equally hard for him to explain why he wants to fly in space. "In my lifetime," he finally reasons, "how many people will be able to go so far up and look down?"

Thirty-seven-year-old Lynn Krinsky of Seattle, Washington, reports that her family has always thought her a little . . . odd. Upon receiving a master's degree in counseling in 1974, she became a special education teacher and then a school psychologist in Cambridge, Massachusetts. In 1979 she switched to selling imported leather goods, traveling extensively around Senegal and Colombia. She gave up the nomadic life in 1980 to market pension plans, but after "five *long* years," in her words, she embarked on an odyssey through Nepal, Thailand, Japan, and Hong Kong. "All

we have in this world is time," she says, "and there's so much to do and see."

Krinsky decided on the spot to book herself a seat on Project Space Voyage upon reading a newspaper article about it: "I air-expressed my check in right away When I decided to go to Nepal, it was because I wanted to see a world I'd had no previous experience with. In space, there's going to be weightlessness and a certain vastness and darkness—all of which I've never experienced. I'll be able to see weather as it moves around the world. Won't that be a trip? I'll see the oceans and the mountains in a new way, and I think I'll really begin to understand the Earth."

But is that knowledge worth \$50,000, particularly to Krinsky? She's in the real estate business now but says, "I'm probably the poorest person booked on the trip." She laughs off the expense, however. "It's the cost of an old Rolls Royce or half of a Steinway piano," she says, "things some people buy without a second thought. For me, it will pay for an understanding of my world, the place where I live. You can't put a price on that I'll have the rest of the money for the trip, no problem."

Meanwhile, Krinsky reports that her mother is skeptical: "When the subject of cash comes up, she says, 'I know where you can get \$5,000.'"

Leroy Nordby of Bellevue, Washington, believes that his life will be incomplete if he doesn't go on Project Space Voyage.



The 51-year-old anesthesiologist spends his leisure time seeking adventures of all sorts. "If I have a personal philosophy," he says, "it's that I discover more and more of myself the more I get out and do the things I do."

Nordby is a pilot, skier, scuba diver, and sailor, and he especially enjoys kayaking off the Pacific Northwest coast. "Sometimes, because I come from a Scandinavian ancestry, I think I would have been a great Norse explorer," he muses. Nordby has journeyed to the Amazon, the Galápagos, and Easter Island, and he's photographed penguins in the Antarctic, polar bears in the Arctic, and killer whales off the Alaska coast.

Intrigued as he is by exotic places, Nordby is captivated most of all by space. An amateur astronomer, he's enjoyed the vicarious thrill of watching others embark on a space voyage. When *Apollo 17* was about to take off, he got a VIP pass to the launch site through his congressman. "It's an experience I'll never forget," he says. "At the launch, the whole sky lit up like an eerie dawn. My keys were rattling in my pocket from the force of the thrust. I'd never felt anything so powerful. It sounded like rolling thunder.... Finally there was just that big ball of fire flying away. All I could think was, *Man, those lucky guys on board.*

Nordby says he considered becoming an astronaut in the early days of the space program, but lacked the perfect vision then required. Now he collects

spaceflight memorabilia—books, buttons, photographs—and launches model rockets. But these hobbies are no substitute for spaceflight, and the cost of his prospective voyage is no object. "When I'm dead and gone, I won't need the money. I want to go to space, and short of taking this trip, I don't know how else I'll ever do it."

If there's anyone who deserves to go into space, it's Vince Gann, whose love for airplanes and flying has no bounds. "I remember the first time I saw an airplane, back in the 1930s," the 65-year-old Southern Californian recalls. "I yelled and started running after it, then followed it with my eyes as far as I could. I used to see the *Akron* and *Macon* airships all the time. Or I'd lay on my sailboat out in San Diego Bay and watch planes all day, coming on and off the aircraft carrier *Langley*. Then when I was in high school, I saved up enough money to buy my first plane," a Piper J-2, with a couple of pals. This led Gann into a career of flying that has included stints for the Central American airline TACA, the Atomic Energy Commission, and General Dynamics.

"The tragedy is that I was born too early to be in the space program," says Gann, who's now retired and free to travel. He's already visited the Antarctic and the Amazon, but he's especially looking forward to visiting Earth orbit. "I can't imagine anyone *not* wanting to go to space. I've been around the world



Lynn Krinsky: "In space, there's going to be weightlessness and a certain vastness and darkness—all of which I've never experienced. I'll be able to see weather as it moves around the world. I'll see the oceans and the mountains in a new way, and I think I'll really begin to understand the Earth."

three times over in my flying career, and it would be a wonderful capper to see the places I've been to from 150 or 200 miles above. There will be some Gs on the takeoff, but that will be no problem for me. And I've had the experience of weightlessness in scuba diving."

Gann says his wife loves to travel but won't be going along on Project Space Voyage. "Let's just say she's somewhat selective about where she goes. But my two daughters think it's great—they'd love to go themselves. In fact, if my creator takes me before 1992, it's going to be quite a battle for who gets to go in my place . . . I've started sleeping with one eye open."

Jean and Lewis Neill of Oak Brook, Illinois, have been married for 45 years, and in the year of their 50th anniversary, they intend to visit space together. "We have adventure in our hearts," says 65-year-old Jean, who surprised 66-year-old Lewis with a birthday gift of reservations for Project Space Voyage. "Of course, after what happened with the *Challenger*, our friends were aghast at our plans. But I'm sure the technology will be perfected five years from now, and after all, we can always cancel our reservations and get our money back. I mean, we certainly wouldn't lay down in front of a train . . . But on the other hand, we're both going to be in our 70s. We've lived our lives. Why not have an experience like this?"

"These days," observes Lewis, "it's risky just going down to the post office." Lewis is semi-retired from his trucking business. He and Jean keep active by skiing, boating, and swimming—and traveling, vigorously. "Back in 1981," Lewis recounts, "Jeannie and I went river rafting in New Zealand. Our raft turned over and we went through the



Ira Sharlip: "I already have a mental picture of orbiting—looking down, seeing how small Earth looks. I think that visual experience is going to give me a greater sense of how the people of the world should really be living in unity."



Richard Headrick: "I believe I'm doing God's will—especially since He's been good to me financially—by trying to have as many interesting experiences as possible. I like to talk to people about Christ, but it helps if I have some other things to share with them too."

Lewis and Jean Neill: "We have adventure in our hearts. Of course, after what happened with the *Challenger*, our friends were aghast at our plans. But the technology should be perfected five years from now, and after all, we can always cancel our reservations and get our money back. We wouldn't lay down in front of a train . . . But on the other hand, we're both going to be in our 70s. We've lived our lives. Why not have an experience like this?"

rapids without it." Jean adds a story of her own: "A few years ago we went ballooning, and the balloon crashed, and Lewis broke his elbow."

In light of these adventures, space will be a piece of cake, say the Neills. "We've visited the NASA space center in Alabama and seen films that give us an idea what the flight will be like. We want to experience the gravitational pull," says Jean. "In the end, what the hell?" Lewis chimes in. "It's just a few thousand dollars the kids won't get."

Ira Sharlip, a 47-year-old urologist in Marin County, California, has a family and says he's not prone to such extravagant gestures as laying down a \$5,000 deposit on a \$52,200 present to himself. He's succumbed just this once, however, for a chance to travel in space. "I'll have \$45,000 put aside by 1992," he says, "but I work hard for a living and I still drive a 1969 Pontiac . . . It may be a frivolous way to spend \$5,000, but I figure I'm entitled."

Still, Sharlip is skeptical about his chances for getting into space. He has yet to be convinced that Society Expeditions can pull off Project Space Voyage. "They have some big steps to take. They are going to be under a lot of pressure to make sure it's not risky. And if





Vince Gann (with granddaughter Lindsay Leadingham): "I can't imagine anyone *not* wanting to go to space. I've been around the world three times over in my flying career, and it would be a wonderful capper to see the places I've been to from 150 or 200 miles above. There will be some Gs on takeoff, but that will be no problem for me."

NASA is having trouble with its shuttles, how is a private company going to put a vehicle into space?"

However, he admits, "the whole idea is terribly exciting. I already have a mental picture of orbiting—looking down, seeing how small Earth and its landmasses look. And I think that visual experience is going to give me a greater sense of how the people of the world should really be living in unity—because we're not that far apart geographically, after all." He also admits that the thrill of spaceflight is alluring. A pilot and former Army flight surgeon, he briefly considered becoming a physician-astronaut for NASA before settling on a career in private practice. But he says he won't be unfulfilled if the space tour never takes off: "I'll have only lost the interest on \$5,000 for a few years—\$500 a year, let's say. I can handle that. Besides, it could just turn out to be something phenomenal, and I don't want to miss it."

The odds that space tours will take off in 1992 are not great. Though brochures for Project Space Voyage display illustrations of a hypothetical single-stage passenger spacecraft, a company spokesman says that Society Expeditions has not decided what type of vehicle to use and is soliciting designs. They may have to look hard; the list of existing vehicles available to them has shrunk.

NASA's space shuttles have been barred to tourists for the past two years, and with the exception of the Soviet Soyuz, no other passenger-carrying spacecraft are in operation anywhere. But the lack of a means to get there from here has never daunted past explorers. If Society Expeditions can't find a way to take these travelers into space, someone else will. ➔



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MARS *Swiftly*

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— Jonathan Swift, *Gulliver's Travels*, Part Three, Chapter III, 1726

by Ken Crosswell

They're small and faint, hardly what you'd expect to find at the center of a great mystery. Despite their Lilliputian size, the two moons of Mars have earned a peculiar place in history: they were accurately described by a political satirist 151 years before any astronomer recorded their existence.

U.S. astronomer Asaph Hall discovered the moons when he trained a telescope on the red planet in 1877. He christened them Phobos (“Fear”) and Deimos (“Terror”)—fitting companions for Mars, God of War.

But Irish writer Jonathan Swift got there first. *Gulliver's Travels*, first published in 1726, describes the journeys of Lemuel Gulliver through lands like Lilliput, where the locals stand a mere six inches tall, and Brobdingnag, inhabited by giants. Gulliver's third voyage is to a remote archipelago ruled by a king who lives on the flying island of Laputa, where scientists have discovered two moons of Mars and determined their orbits as well.

Ironically, Swift's prescient astronomers appear in a work in which he pokes fun at science. Swift was no stranger to science. He lived in an era of great scientific progress: Johannes Kepler had deciphered the laws governing the planets' movements about the sun, Galileo Galilei had discovered four moons orbiting Jupiter, and Sir Isaac Newton had attempted to explain it all through a universal law of gravity.

But Swift saw danger in the presumption that humans can, through scientific reasoning, attain a god-like stature. Swift saw this craving for perfection as, ultimately, a craving to relinquish humanity. Indeed, Gulliver's fourth and final voyage takes him to a land where reason and virtue reside in horses (“Houyhnhnms,” as they call themselves) and humans are barbarians, leading Gulliver to make “a firm resolution never to return to human kind.”

Swift fires his most damaging volleys at scientific enterprises in depicting Gulliver's third voyage. On the islands, Gulliver encounters scientists and mathematicians wandering about so lost in thought they must be struck slightly by their assistants in order to start a conversation. He met “a most ingenious architect who had contrived a new method for building houses, by beginning at the roof, and working downwards to the foundation.” Others were performing experiments aimed at “softening marble for pillows and pin-cushions; others petrifying the hoofs of a living horse to preserve them from foundering.”



When Gulliver, cast adrift by a mutinous crew, first glimpses Laputa, he suspects it's just pie-in-the-sky.

At Laputa's helm is a band of astronomers who control the island's flight through the air. These astronomers are far superior to those in Europe. They've discovered 93 comets and have cataloged three times as many stars as their European counterparts. And, because they're so good, they "have likewise discovered two lesser stars, or satellites, which revolve about Mars." Lest any reader doubt the existence of these hitherto unseen worlds, Swift even provides orbital parameters. The inner moon, he claims, lies three planetary diameters from Mars and circles the planet every 10 hours. Its mate lies five diameters out and orbits every 21.5 hours.

According to Kepler's laws, the farther a satellite is from its planet, the longer it takes to complete an orbit. Further, as a consequence of Newton's law of gravity, Kepler's laws specify the precise relationship between a satellite's distance and its orbital speed, and Swift's numbers conform to these laws. As he himself notes, "[T]he squares of their periodical times are very near in the same proportion with the cubes of their distance from the center of Mars, which evidently shows them to be governed by the same law of gravitation, that influences the other heavenly bodies."

But Swift tucked an absurdity into what might otherwise seem reasonable numbers. Every satellite known in 1726 takes longer to orbit its planet than its planet takes to rotate. Our moon, for example, circles Earth every 28 days, while Earth requires only one day to turn once on its axis. Swift's moons flagrantly depart from this pattern: both have orbital periods shorter than the Martian day, which is 24.6 hours.

Swift's strange moons remained fiction until 1877, when Asaph Hall embarked on a search for Martian satellites. He began the hunt, he said later, because he was tired of reading in textbooks that Mars had no moons. Hall knew his quest wouldn't be easy. Great astronomers had looked before and found nothing, and few believed Mars had any companions. Tennyson even penned a poem that mentions "the snowy poles of moonless Mars." Clearly, any moons circling Mars would have to be small and faint.

Fortunately, 1877 was a good year for Mars observations. The planet was close to Earth, and Hall armed himself with one of the best telescopes in the world at the time: the newly constructed 26-inch refractor at the Naval Observatory in Washington, D.C.

Hall started work in early August of 1877, systematically observing the area of the sky near Mars. Now and then he spotted suspicious objects beside the planet, but in every case, they proved to be stars. He was about to call it quits, but his wife urged him to return to the telescope. He dutifully obeyed, and at around 2:30 a.m. on August 11, he detected an object that looked promising. He recorded its position just in time: fog rose from the Potomac River moments later and prevented further observations.

Hall waited all night for the sky to clear, but it remained cloudy till dawn. The next five nights were cloudy as well, and it's not hard to imagine Hall pacing about the observatory, peering at the starless sky. When the skies finally did clear, on August 16, Hall made up for lost time. He quickly located the first satellite and, on the following night, discovered a second moon closer to Mars than the first.

So Swift had been right all along: Mars did have two satel-

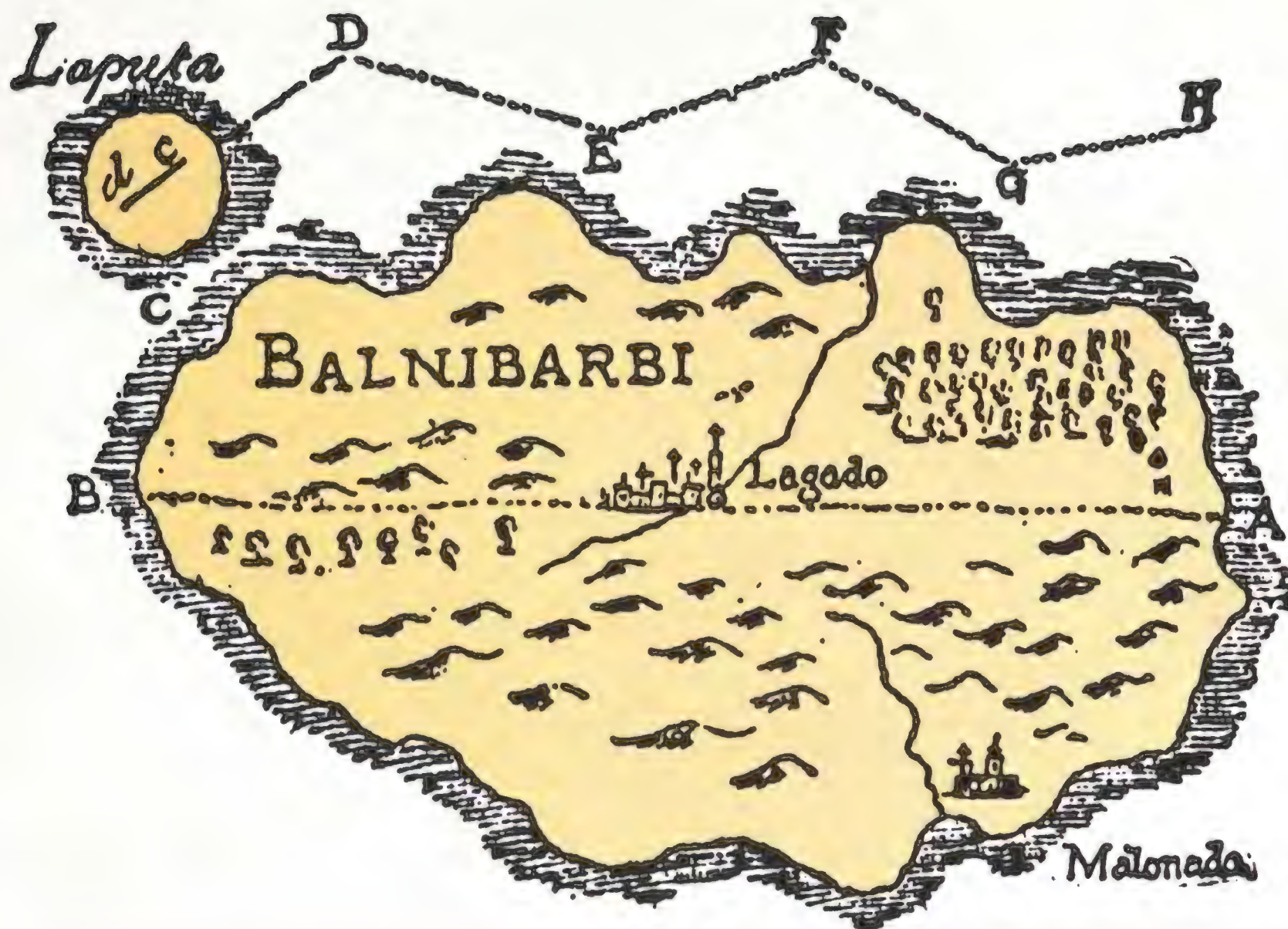
lites. But as Hall examined the new moons, it became clear that Swift had done more than just predict the number of Martian satellites; his figures for the orbits weren't far off, either. The inner moon, Phobos, lies 1.4 Martian diameters from Mars—Swift said 3—and orbits Mars every 7.7 hours, close to Swift's 10. The other moon, Deimos, is 3.5 diameters from the planet, versus Swift's 5, and circles with a period of 30.3 hours; Swift said 21.5.

Furthermore, Phobos *does* circle Mars faster than Mars rotates, just as Swift had written. It was the first satellite



Astronomers of the Laputan archipelago attempt to instruct Gulliver in the planetary sciences.

Illustrations courtesy Griffith Observer



Secrets of the Satellites

To Asaph Hall, the moons of Mars were mere points of light glimpsed through a telescope. To astronomers today, however, Phobos and Deimos are tiny worlds that could become important way stations for manned expeditions to the red planet.

Although three spacecraft—*Mariner 4*, *6*, and *7*—flew past Mars in the 1960s, we Earthlings didn't get a good look at the Martian moons until *Mariner 9* went into orbit around Mars in 1971. It scrutinized the planet and its moons for nearly a year, taking photographs that revealed the satellites as potato-shaped and heavily cratered.

In 1976 the Viking program sent two spacecraft into orbit around Mars and two landers to the Martian surface. The Vikings sent back superb photographs of both satellites.

Thanks to these spacecraft, we now know far more about the moons than we did 20 years ago. Phobos, the inner moon, is nearly twice as big as Deimos, but both are tiny—Phobos is some 14 miles across; Deimos, 9. And the moons are dark: they reflect only six percent of the sunlight shining on them.

Scientists suspect Phobos and Deimos are captured asteroids. Most asteroids orbit the sun in the asteroid belt, between Mars and Jupiter. Like

Phobos and Deimos, asteroids are small and often dark. And, although we've never seen one close up, a typical asteroid is thought to be pocked with craters, just as Phobos and Deimos are.

Because the moons are so small, they have very little gravity. A 100-pound object on Earth weighs only an ounce on Phobos, and the escape velocity for Phobos is a mere 25 mph. If you took off from Phobos at this speed, you'd escape the pull of the satellite's gravity altogether. The smaller moon, Deimos, has an even lower escape velocity—just 15 mph. These low escape velocities will make it easy to get materials off the surfaces of the moons for use either in orbit around Mars or on the surface of the planet. Because Earth is much more massive and has such great gravity, transporting materials from our planet would be very expensive. The moons will therefore play a central role in manned exploration of Mars.

Science fiction writers have long eyed Mars as a potential human habitat, and more recently Soviet and U.S. space program planners have joined them. The Soviets plan to land an unmanned probe on Phobos in 1989 to determine the composition of the satellite's surface—vital information for future explorers. It will be the first spacecraft to land on a satellite of another planet.

—Ken Croswell

She may not steer a true course (left), but the good ship Laputa can come in handy in literally crushing rebellions on neighboring isles (right).



found to orbit faster than its planet rotates.

As astronomers hailed the discovery, most regarded the remarkable agreement between Swift's fictional moons and the actual objects as nothing more than coincidence. But a few dissented. Some suggested Swift had divine insight. Others argued the author had something else: access to ancient texts. In his best-selling 1950 treatise on astronomy's role in history, *Worlds in Collision*, Immanuel Velikovsky wrote: "It is an even chance that Swift invented the two satellites of Mars and thus by a rare accident came close to the truth. But it may also have been that Swift had read about the trabants in some text not known to us or to his contemporaries."

The truth turns out to be a bit more down-to-Earth, and we don't have to look far for the source: Johannes Kepler. There's no doubt Kepler was a great astronomer, but he was also a mystic and a believer in numerology, obsessed with a search for order and numerical patterns in the heavens. One of Kepler's pet numerical sequences involved the number of satellites orbiting each planet. Kepler was sure there was a pattern: Mercury and Venus, the innermost planets, had no moons; Earth had one; Mars had an unknown number; and four of Jupiter's moons were known at that time. Since Mars lies between Earth and Jupiter, Kepler thought the number of Martian satellites should be between that of Earth and that of Jupiter. Kepler chose two—twice as many as Earth, half as many as Jupiter.

The argument is ridiculous, of course, and Swift probably knew it. His mention of the two Martian satellites in *Gulliver's Travels* is probably a jab at Kepler and other mystical scientists. Swift went further than Kepler would have dared, though, in stating orbital radii and periods for the satellites.

It is said that every criminal leaves a piece of evidence at the scene of the crime that gives him away. If we look closely at Swift's numbers, there is something slightly awry, something that suggests Swift just made his numbers up. In addition to describing the relationship between satellites' positions and speeds, Kepler's laws state that the more massive a planet, the faster its moons must move to keep from falling into it. A satellite can therefore reveal the mass of the planet it circles. The numbers for Swift's moons imply a mass for Mars that is six times greater than the true Martian mass, giving the red planet a density greater than lead.

Well, as Swift would have been the first to admit, nobody's perfect. But he got more right than wrong. And he's even earned recognition from the astronomers he loved to satirize; one of the craters on Deimos now bears the name Swift.

Let's just hope no one ever discovers a third Martian moon. That would spoil everything. —



The Laputan monarch epitomizes his subjects' fascination with objects mechanical. His pages keep their paddles handy to prevent him from slipping into too lengthy a reverie.

The Birdman of Queens

Racing pigeons almost always find their way home—fast. Scientists would like to know how.

by John Grossmann

Photographs by C. Traub & J. Gordon/Wayfarer

It's early yet, but Tony Accardi is already staring at the sky.

Visible to the west from his backyard, one of the highest points in Queens, is the Manhattan skyline. But Accardi is looking, as he nearly always does, more to the south, where there is only sky—and the promise of pigeons.

Accardi is waiting at his loft for 25 birds, his entries in the first annual Statue of Liberty Race, to return home. The pigeons, 14 hens and 11 cocks, have been on the wing since leaving from Charlottesville, Virginia, six hours ago. Shielding his eyes against the October sun, Accardi scans the sky. He wears black-framed spectacles, his grayish white hair is combed back from his forehead, and a thin mustache tops his upper lip like a circumflex accent mark. Nestled in the hair at the back of his head, unnoticed by him, is a tiny white pigeon feather.

After checking his pole-mounted weather vane and noting a favorable tailwind, Accardi silently crunches a few numbers. Liberation time: 8:45 a.m. Distance from Charlottesville: about 300 miles. Figure two hours and 20 minutes to fly 100 miles. That's seven hours; the winds should cut that by a half-hour.

"We should clock our first bird at 3:15," he announces, with the mixture

of confidence, faith, and hope so characteristic of veteran pigeon fliers. Never mind that his birds are only eight months old and weigh less than a pound. Or that before their arrival in Charlottesville, where they were released simultaneously with 1,156 other New York-area pigeons, they had never been anywhere near Virginia. They'll return. Accardi is certain of that.

Accardi started raising pigeons when he turned 13, the year the stock market crashed, and except for breaks for World War II and his wedding, he has been at it since. A former feed salesman and pet store operator, he's clocked his share of winners during those 57 years of breeding, training, and racing. Pigeons bought him his Queens home—complete with six lofts and a two-room, glass-wall office—as well as 179 acres in upstate New York. Still, like most pigeon fliers, known as fanciers, the money is a secondary consideration. He's happy if he covers expenses, "plus a little, maybe."

Covering expenses takes some doing. Even wholesale, as he gets them, 100-pound bags of feed go for \$16. Accardi's

Home is where the loft is: Tony Accardi's birds roost on a big spread other fanciers call The Ponderosa.







Once sealed by judges, racing clocks are ready for the "bang off." A broken seal means disqualification.

200-odd birds, easily three or four times as many as most fanciers keep, empty six bags a week. Medicine and identification bands add to the total cost. So do crate fees, as much as \$10 a day, paid to a truck driver who transports birds from dozens of area lofts for their early morning training flights—at first 25 miles, then 50 miles away.

Accardi also keeps precise genealogies in order to make shrewd pairings in the wintertime breeding season. "I love to breed pigeons and see what comes out in the end," he says. He never knows what he's got until race day, but he can see signs in the training flights. A bird's conditioning shows in its vasculature, particularly the blood vessels beneath the pigeon's downy breast feathers. Some fanciers claim they can judge birds by an "eye sign," a certain glint of readiness. Accardi goes by feel. "It's like cracking a safe," he says. "Every-

thing's in the feel of your hands."

Each morning he's up at five: cup of tea, check the birds. About six, he's got his crates over to the truck, which departs promptly at 6:40 from a supermarket parking lot. Then there are cages to clean. A pound of feed, Accardi has learned, produces pretty near a pound of manure ("It's just about bag for bag"), some of which makes it into

the garden near his oldest loft, which he calls The End. Before long, it's time to check the sky for the birds and teach them to descend quickly to the landing board. "It gets to the point where there aren't enough hours in the day," says Accardi, who's been retired for several years and rarely travels.

Today, as he waits for his birds to return, Accardi half-fills a coffee can with feed and shakes it. The dried corn-and-pea mixture makes a reassuring, stony rattle. "I'll keep them happy when they return," he says.

Pigeons have been returning home for centuries. Originally, their ability to home in on their nests brought them back to cliffside perches above the Mediterranean after long flights in search of food. Man got into the act around 3000 B.C., when the ancient Egyptians began training the birds. After conquering Gaul, Julius Caesar used carrier pigeons to send word of his victory back to Rome. When Baron Paul Julius von Reuter founded his news agency a hundred years ago, he used pigeons to transport information between the end points of different telegraph lines. In the two world wars, pigeons helped save scores of lives by calling in reinforcements and, in some instances, calling off wayward artillery fire.

Even today the pigeon earns its feed. The Lockheed Corporation has used them to send microfilmed plans be-



Accardi turns a key for a race's bang off. At race's end he will play beat the clock to check in returning birds.



tween plants in the West. And at the Snake River in Wyoming, pigeons shuttle film to the lab and back so vacationing rafters can have same-day pictures of themselves braving the rapids.

How pigeons navigate so well continues to intrigue and baffle scientists. In the name of science, pigeons have been tracked by airplane, released with frosted contact lenses clouding their vision, sent aloft with magnets on their backs, even driven to release sites while atop a rotating turntable to prevent them from remembering the turns along the way—all in an attempt to understand a natural talent for navigation comparable in many respects to systems aboard sophisticated aircraft.

The center of pigeon research lies outside Ithaca, New York, at the busy lofts maintained at Cornell University by the 20-year-old Cornell Pigeon Project. Today the lofts' avian population typically exceeds 1,500 and consumes some 11 tons of feed a year. From April to October batches of experimental and control birds are shipped off—north, south, east, west, and all points in between—and released.

On a big map in the communal office adjacent to the lofts, the releases are

plotted as a dizzying array of arrows, many pointing to everywhere *but* Ithaca. After years of studying the results, researchers are homing in on some theories, but as the map suggests, pigeon navigation remains a mystery.

"I think these birds are opportunists, just like people," says Charles Walcott, executive director of Cornell's laboratory of ornithology. Walcott observes that people in Manhattan find their way around with help from street signs and distinctive buildings; out West, perhaps with one eye on the mountains. "Maybe in different places and under different circumstances, pigeons use different cues," he says.

The evidence indicates that pigeons have at least two compasses. The best understood is a sun compass they learn to use when young and apparently prefer when skies are clear. The sun compass has been demonstrated at Cornell by keeping pigeons for several days in a windowless, closet-sized room where overhead lights mimic the sun. For clock-shifted birds, sunrise (lights on) and sunset (lights off) come six hours earlier than they do in real time.

Irene Brown, an investigator who worked with the project's founder, the

At the United Bronx Pigeon Club activity starts on race eve. The pigeons will take wing the next morning.

late William Keeton, explains what happens when a bird is taken to, say, the north and released: "He checks his internal clock and says, 'It's six in the morning. I know the sun is east. I know I have to fly south to go home. South is always to the right of east.' He goes off to the south very nicely. But the clock-shifted bird thinks it's noontime. 'I know my home is to the south,' he says, 'and I know at noon the sun is to the south.' So he goes off to the sun—to the east. How far does he fly before he realizes his error and puts on the brakes? We really don't know. Some clock-shifted pigeons make it back that same day. Some never return."

But pigeons can also home perfectly well on overcast days, indicating that the sun isn't their only means of orientation. Some scientists theorize that pigeons can detect and utilize the earth's magnetic field. For years skeptics pointed out that even a toy magnet is stronger than the earth's field, but when Cornell pigeons were released on over-

cast days with bar magnets fixed to their backs, they circled uncertainly, clearly disoriented. Pigeons released over subterranean magnetic deposits have also failed to orient properly.

Italian research, supported by some U.S. studies, suggests pigeons use olfactory cues for orientation. Other studies have shown that, contrary to previous belief, pigeons can see polarized light and hear very-low-frequency noises such as the distant sound of wind

rustling over a mountain range or waves breaking on a shore. "Are these abilities involved in orientation?" asks Walcott. Again, he has no answers.

Scientists also don't know how a pigeon figures out where it is when it's released. Without knowledge of location, a pigeon's directional information would be as useless as a compass to a Boy Scout lost in an unfamiliar wood. But within a few wingbeats, a pigeon trucked to unfamiliar territory can un-

fold its map, check its compass, and head straight for its loft.

"Maybe God put pigeons here on Earth to make man more humble," says Brown, rather happily perplexed.

Pigeon fanciers like Tony Accardi are less interested in how the birds make it home; they want to know *how fast*. In much of Europe, pigeons are discussed as passionately as the local soccer team. In Belgium, where betting—"playing the pigeons"—is legal, the daily papers

(All I Need Is) The Heir That I Breed

To paraphrase George Orwell's *Animal Farm*, all pigeons are equal, but some pigeons are more equal than others. Take, for example, the pampered racing pigeons that belong to Hervey Thomas "Chic" Brooks, a restaurateur from Fresno, California.

Brooks, 60, owns around 100 pedigreed racing pigeons and 255 breeding pairs. The birds have a stable, breeding pens, and race loft that share 15 acres with Brooks' brand-new ranch-style mansion. For training, Brooks sometimes flies the pigeons to their release sites, loading crates of birds into the back of his turbocharged Cessna 210, then releasing them at distant airstrips for the flight home. Otherwise, Brooks says, the only thing separating him from fanciers with less disposable income is that he can pay someone to clean the pens.

"Pigeon racing is kind of like shooting dice," says Brooks. "But I always work on the theory that they can't take more away from you than you had to start with. And I didn't have nothing to start with."

Brooks' passion for pigeons began when he was eight years old and growing up on a farm in Windsor, Missouri. He traded a jackknife his father gave him for Christmas with another kid for an "ol' barny," a close relative of the common pigeons that decorate city monuments. It was a trade that almost didn't happen. "I'd have traded for a kitty if I could've," Brooks admits.

"I got the tar whaled out of me when my daddy found out," he says, "but he didn't make me take it back." Within a few years Brooks had about 40 pigeons roosting in old nail kegs he put up under the eaves of the family garage.

Brooks dropped out of high school after the 10th grade and joined the merchant marine. When he was 23 he bought a grocery store with 835 borrowed dollars;

14 years later he sold it for \$175,000. That money went into a steak house franchise in Fresno, and five years later Brooks founded Happy Steak, now a meat packing plant and chain of 103 restaurants that last year grossed nearly \$56 million.

But Brooks is still the picture of a country boy. His accent calls to mind a childhood spent behind a plow, and he comes to work at Happy Steak in a worn jacket with a hole in the sleeve. Out at the ranch it can be difficult to tell who hired whom to clean out the pigeon stalls.

While building his fortune, Brooks found it difficult to find time for pigeon racing, the one thing that kept him from "going crazy." When he was in the grocery business, Brooks learned to fly and bought an Aeronca Sedan for pigeon training. "The only way I could get 50 or 60 miles on the birds," he says, "was to run out real early, put 'em in the plane, fly 'em up the line, release 'em, and get back to the store by eight a.m."

Throttled back, he could also fly over the birds as they returned. He discovered that racing pigeons don't fly home in a straight line, sometimes veering as much as three to five miles off course. He also noticed that they tend to fly in flocks, which means that the person entering the most birds in a race

Jordan Coonrad



Chic Brooks' pigeons sometimes fly first class in a Cessna 210.

has a distinct advantage.

Although Brooks has won as much as \$17,000 with a single bird in a single race, his pigeon profits come mostly from breeding. In 1975 he visited Holland, Belgium, and West Germany and spent \$10,000 on pedigreed birds. "I had no intent of starting a breeding business," he says. "Then I sold \$10,000 of babies right off the ones I just bought. So I figured I might be missing the boat. I might as well go ahead and do this thing up right."

In the past four years Brooks has spent \$100,000 on breeding stock, paying as much as \$5,400 for a single pair. He sells about \$60,000 to \$90,000 worth of young pigeons a year to buyers around the world and once sold a single pigeon for \$3,200. Still, that's small potatoes compared with prices in Europe, where last year a bird fetched \$40,000.

Racing-pigeon pedigrees rival those of the House of Windsor. For example, Brooks owns Red Poot, the last living offspring of a famous pair called Poot and the Red Hen. Red Poot is 18 years old and has a broken wing, but Brooks still sells his offspring (as many as 39 in a single year) for \$650 each.

While pigeon breeding has become a good business, racing is still Brooks' great delight. One hundred birds share the two-story race loft, which looks like a small house in the suburbs except for the barred windows. During the races Brooks sits in a lounge chair under a patio umbrella on the second-floor balcony and waits for his pigeons to come home.

"I think a pigeon race is a poor man's horse race," says Brooks, who also owns 91 quarter horses. "I had a horse in the All American Derby about two years ago and, so help me, I got no bigger thrill out of that than I get from seeing one of my pigeons coming out of the sky from a 600-mile race—even though there was about a \$500,000 difference in the purse."

—Elaine de Man



No gilded cages for these birds. Trucked away to release points hundreds of miles away, they'll return home like feathered boomerangs.

Registration forms, clocks, and race bands are all necessary for races with myriad finish lines.



print race results as U.S. newspapers do baseball scores.

The sport is not as popular in the United States, where only about 13,000 people keep pigeons and belong to local clubs that sponsor races. Accardi belongs to the Elmhurst Homing Pigeon Club. The night before the club's first Statue of Liberty competition last year, Accardi and other determined fanciers, all bearing their best young birds, met for an important pre-race ritual at a former auto body shop in an industrial section of New York's Ozone Park.

"Quiet! Thirty seconds," shouted a club official standing inside a corral of tables, announcing the countdown for the 8 p.m. "bang off." Pressed elbow to elbow around the tables were a couple dozen members of the Elmhurst club. Like almost everybody else, Accardi was already fingering a key in the top of his racing clock. With each loft constituting a different finish line, there could be no race, no certifying arrival times, without these clocks. They are first sealed by officials with a wire crimped with soft lead, then synchronized in batches—each starting off with a bang when engaged by the key. As

soon as a pigeon returns to its loft, a special numbered race band—its countermark—is removed from its leg, inserted in a metal capsule, and the capsule shoved into a hole atop the race clock. Inside the clock, a paper ticker records the time.

Time alone does not determine the winner. Since the lofts lie different distances from the release point, all have different "air lines" certified by precise survey. Thus, races are judged not by time on the clock but by speed—in yards per minute—which is figured later in the day by club officials who open up the race clocks and work numbers like math students.

With another bang off imminent, the nervous chatter in the cement-floored garage subsided a few decibels. By the door, a line ten deep led to a window where fanciers anted up transportation fees to truck the birds to Virginia for the race's start. Some heightened their interest a bit by entering certain birds in various betting pools.

"Ten seconds . . . three, two, one."

The bang off sounded like a smart, quick drum roll as all keys turned within a split second of one another. Their

clocks running, the fanciers dispersed. Accardi headed for the two crates of birds he had brought—one for males, one for females—and took them to be countermarked.

Once his birds were banded, Accardi surveyed the crowd. "See all these guys? They're playing for keeps," he said. He told of one fancier who built his loft on a wheel that spun like a weather vane, keeping the landing board always pointed into the wind and maybe saving a second or two. "You're always scheming. You've got to figure a way to beat the next man. Your brain is working overtime. Still," he allowed, "I've seen a man come in with one bird in a paper bag. He won the race. It only takes one, right?"

Now, on race day, it is up to the pigeons. Accardi waits in his backyard, staring at the sky. No birds yet. He pads over to the office in his stockinged feet to telephone a couple of other lofts; with a first prize of \$5,000 at stake, the phone lines among the lofts will be humming today.

"Nothing yet," Accardi announces to the three others who have joined him—two former fanciers and his friend



Sammy D'Amico. Accardi's phone rings at 3:15, and again two minutes later—clouds are beginning to darken the sky over Manhattan. Loft to loft, everybody's talking about an earlier storm in Maryland. They deliberately avoid mention of a "smash," a major bird loss, which eventually strikes most pigeon clubs. One of the worst smashes on record hit a central New Jersey club on October 20, 1985. Of the 3,800 birds liberated in Pennsylvania that day, only 15 had made it back 24 hours later. Nobody knows what happened, but a lot of well-bred pigeons are probably now living on farms, mingling with chickens.

Suddenly there's a pigeon. Unseen winging in, perhaps blown north by the storm, it flutters to the landing board on the loft nearest the office. "Come on, come on," coos Accardi as Sammy slides over to grab the bird, remove the countermark, and clock it in. A clumsy move—anything that might send the bird on even a brief overhead circle—could lose a race: sometimes, even in a seven-hour race, only a second or two means the difference between first and second place. The clocking goes smoothly. Accardi checks the time: 3:20. The pigeon, a blue cock, number 1075, has just flown 305.947 miles.

Another bird flutters into sight. Accardi recognizes it as the bird he's entered in one of the big betting pools. "That's the auction bird," he says. "Beautiful. His brothers and sisters were winners for me." Sammy clocks the pigeon in at 4:06. At 4:20, first one pigeon, then another, and yet another

Before his pigeon is trucked to a race's starting line, a fancier says goodbye—or probably just au revoir.

Though hardly a cheering sight for most New Yorkers, racing pigeons head for home, not Central Park.

alight on the landing board. A couple of clockings later, Accardi calls it a day. Experience tells him the race is over.

Buoyant, Accardi drives back to Ozone Park and turns in his clock to race officials. His years of experience, however, do not prepare him for what happens next.

"Sorry, Tony," an official says, returning the unopened clock. "I can't accept it."

Accardi stares, dumbfounded. Then he, too, spots the unthinkable. The wire bearing the chunk of lead that seals the clock is broken. Accardi starts to protest, then realizes there's not a thing he can do. "I know," he says, trying to get command of his voice. "A rule is a rule. It's a shame. A damn shame." He walks out of the garage—fast.

Driving home, Accardi says that anybody who opened the clock would see it hadn't been tampered with. "It shows you've got to watch everything. You can't relax. Even for a minute."

Two days later, he's already talking about the next race, another 300-miler that very Saturday. There's no hitch in his voice, no bitterness. He's got birds aloft at this very minute, heading for home. —





The High-Flying Legacy

This space pioneer invented the aerospace plane . . . 50 years too soon.



by Helmut Muller

During World War II, Wernher von Braun's V-2 rocket became a sinister symbol of Germany's exploitation of science. But if Eugen Albert Sänger, a young Austrian scientist working in secrecy for the Luftwaffe, had been able to bring his own weapon design to fruition, von Braun's ballistic missiles would have seemed tame by comparison.

At his research laboratory in the small town of Trauen in northern Germany, a craft took shape on Sänger's drawing board that would travel at ten

times the speed of sound and, like a stone tossed across a pond, skip along the upper reaches of the atmosphere carrying a four-ton bomb. It was called the "Amerika Bomber," and its target was to be New York City.

Luckily for New York, Sänger was a half-century ahead of his time.

If scientists are judged by their legacies, then Sänger is a giant. Yet despite his contributions to the advance of space exploration, despite his many honors and awards—even a crater on the moon is named after him—the engineer's ulti-

of Eugen Sänger



mate reward eluded him. His hypersonic rocket airplane was never built. A space pioneer whose classified work left him scarcely known outside elite inner circles—although pirated copies of his top-secret Amerika Bomber thesis can be found in virtually every military establishment—Sänger formulated visions that were too advanced to be accepted by his contemporaries, including his wartime employers.

Even today, the transatmospheric vehicle that Sänger was readying in 1941 for the Nazis to hurl at New York is an

advanced concept. It is the technological forebear of Sänger II, the European aerospace plane unveiled by Germany at last year's Farnborough Airshow and projected for flight in 2005.

Sänger II is to be the posthumous realization of a boy's dream of flight to the stars. Incorporating much of Sänger's early work with ramjet engines and advanced rocket propulsion, it is a two-stage, low-Earth-orbit shuttle design, capable of horizontal takeoff and landing from any conventional airport. It is also the last in a single-minded progression

The ramjet promised high performance in a simple package. This test engine atop a Dornier bomber could have reached 600 mph.

of attempts to build the Silverbird, Sänger's first concept of a manned, winged vehicle that could reach space.

"My Silverbird will fly!" Sänger wrote in his diary in 1929, at the age of 24. It would be a costly obsession. In the pursuit of knowledge, he would spend much of his life behind the barbed wire



A one-ton-thrust rocket engine spews fire during a static test at the secret aerospace lab in Germany.

Europe was about to explode into war, and Sänger believed there was no way out but up.

of secret government installations, his experiments directed by politics.

Born in 1905 in Pressnitz, a village in the former Kingdom of Bohemia, Sänger grew up when young Europeans were reading *On Two Planets* by Kurd Lasswitz, a German H.G. Wells. Later, Sänger studied the work of German space pioneer Hermann Oberth. Oberth's 1923 book *Rocket to the Planets* persuaded him, as it would Wernher von Braun and others of that generation, to devote his life to aerospace. Europe was about to explode into war, Viennese society was languishing in past grandeur, and Sänger believed that there was no way out but up. "Everything," he wrote in 1935 while engaged in research at the Technical University in Vienna, "serves the sole purpose of man's leaving earth."

But the conservative scientific establishment at the university refused to acknowledge Sänger's aerospace ambitions. He was advised to choose a "serious" subject for his doctoral thesis, "unless you want to be an old man with a very long beard before you graduate," one of his professors warned. He obtained his doctorate in 1929 on the subject of direct and indirect loads on aircraft wings, and later, as a research

assistant at the university, he began developing liquid-fuel rocket engines to power the Silverbird. In countless static tests performed from 1930 to 1935, Sänger perfected a "regeneratively cooled" liquid-fuel rocket engine. The engine was cooled by its own fuel, which circulated around the combustion chamber in a jacket of tubing, thereby absorbing heat. This engine produced exhaust velocities of some 10,000 feet per second; von Braun's V-2 engine had achieved only 6,560 feet per second.

The university, unaware of the significance of Sänger's progress, took little notice of his work. Eventually, university administrators prohibited the rocket tests because of protests over noise. Sänger approached Austrian military authorities, but they too failed to see the import of his achievement. Believing that rockets would never compete with artillery, they denied Sänger's appeal for support.

Sänger was out of work. His marriage began to falter. But his fortunes changed abruptly: in Germany, there were those who saw a use for Sänger's research.

Hitler's war machine, committed to the development of new technologies, was alert for those who could produce them. In June 1935 and February 1936, Sänger had published articles on rocket engine-powered aircraft in *Flug*, an Austrian aviation publication. In 1936 the Austrian rocket engineer received an invitation from the German High Command to build its first secret aerospace research institute in Trauen. Almost overnight, Sänger was transformed from an unknown, eccentric genius to one of the most valued scientists in the German Reich. He was 30 years old.

At Trauen Sänger immersed himself in work. Together with a staff that would soon include the brilliant and determined mathematician Irene Elisabeth Bredt, he hoped, under the guise of the Amerika Bomber project, to build the first manned spacecraft.

Because of the secrecy surrounding weapons research, Sänger did not realize at the time that he had a competitor in the space race. The German army, in direct competition with its air force counterpart, the Luftwaffe, was supporting the young and brilliant Wernher



Mathematician Irene Bredt confers with Sängner at their World War II research laboratory. Having shared the ordeal of the war and countless Allied interrogations, they married in Paris in 1951.

von Braun at Peenemünde.

Knowing that the rocket engines that were to power his aerospace plane could not attain the Mach 25 escape velocity required to orbit Earth, Sängner came up with an ingenious solution. His bomber could travel farther, he proposed, by skipping along the top of Earth's atmosphere. He calculated that by accelerating his 100-ton bomber on a two-mile rail sled to Mach 1.5 and then releasing it to burn its 90 tons of fuel during its initial leap upward, he could achieve Mach 10, enough speed to allow the bomber to transport a four-ton payload as far as New York at an altitude high enough to render it invulnerable. It would continue on its skip trajectory to land, glider-like, back at its point of launch. The entire flight would take three hours and 40 minutes.

In a series of static engine tests, the last of which demonstrated 2,200 pounds of thrust at a burn duration of a phenomenal 200 seconds, the engineers came one step closer to building the 100-ton-thrust engine they needed. Sängner was confident. He and Bredt completed the calculations and submitted the final Amerika Bomber proposal to the Luftwaffe High Command. The proposal called for a fleet of 100 bombers and, to dramatize the effectiveness of the proposed weapon, included a description of a hypothetical attack on Berlin. Sängner was installing final facilities for full-scale engine tests when, in 1941, Hitler attacked Russia.

Because of that campaign, Berlin was forced to abandon futuristic projects. Sängner's bomber would have taken five to eight years of intense effort. Wernher von Braun launched his first successful V-2 within a year. Under the name Aggregate-4, or A-4, it lifted off on October 3, 1942, the first rocket to break the sound barrier. The Amerika Bomber project was canceled.

The Luftwaffe did its best to stop Sängner from distributing his published research results, though a few copies of a limited secret edition went unaccounted for. Sängner, totally committed to his life's work, was aghast. Although he continued his research contract with the Luftwaffe, in 1942 he resigned his post as director of the Hermann Göring Research Center in Trauen.

His Amerika Bomber work stopped,

In the postwar years, Sanger became a tireless proponent of an independent space program for Europe.

Sanger immediately turned to the technology that would ultimately power his aerospace plane. Drawing on engineer Rene Lorin's 1908 French patent, which showed that air compressed in a tube and then expanded by combustion could provide thrust, Sanger concentrated on developing air-breathing ramjet power plants for use as propulsion units in fighter interceptors.

In a series of ignition tests performed in October 1941, Sanger proved that ramjet combustion could be sustained. A sewer pipe mounted on an Opel truck and driven at 55 mph was injected with a steady spray of gasoline, which was then ignited. The resulting combustion was dramatic, and, more important, it was continuous; the next step was to convert that combustion efficiently into thrust. Through painstaking observations, measurements, and calculations, the last by Irene Bredt, Sanger searched for the optimum combination of fuel, injection process, chamber dimensions, and temperature that would produce the greatest thrust, given the limited tolerance for heat of the available materials.

Despite pressure from the Luftwaffe to show results, Sanger, a scientist first and defense contractor second, insisted on gathering sufficient experimental data. In the first successful in-flight test, performed in March 1942, a 1.5-foot-diameter ramjet engine producing 2,400 horsepower was mounted on a twin-engine, propeller-driven Dornier Do 17Z aircraft. The rapid progression of tests, which culminated in a 4.5-foot-diameter, 20,000-horsepower ramjet engine mounted on the heavier, twin-engine Dornier Do 217E-2, almost

ended in disaster. During one test flight a leaky gas valve caused fuel vapor to fill the cockpit. Had pilot Paul Sprenberg not managed to force open a window as he landed the airplane, he, Sanger, and a mechanic would have suffocated.

By September 1942, Sanger no longer controlled the research institute in Trauen, and in-flight tests were transferred to the Horsching air base near Linz in Austria. By this time, his engine could theoretically produce a maximum speed of 600 mph. This speed was never realized because running the ramjet at full throttle threatened to tear the carrier aircraft apart. Sanger was nonetheless satisfied with the engine's performance.

Again, the realities of the war intruded. Germany had lost its air superiority and was being bombed into defeat. Better fighters were desperately needed to stop the Allied advance. The Messerschmitt aircraft company asked Sanger to equip the high-performance Me 262 twin-jet fighter with auxiliary ramjets to improve its performance. Sanger's preliminary calculations showed that two additional ramjets mounted atop the existing turbojet engines would reduce the Me 262's time to climb to 33,000 feet from 26 minutes to a mere six. But he resisted the Messerschmitt request. The scientist's integrity ran afoul of political necessity. How this engine would perform on the Messerschmitt he could only guess, so he advised against its use.

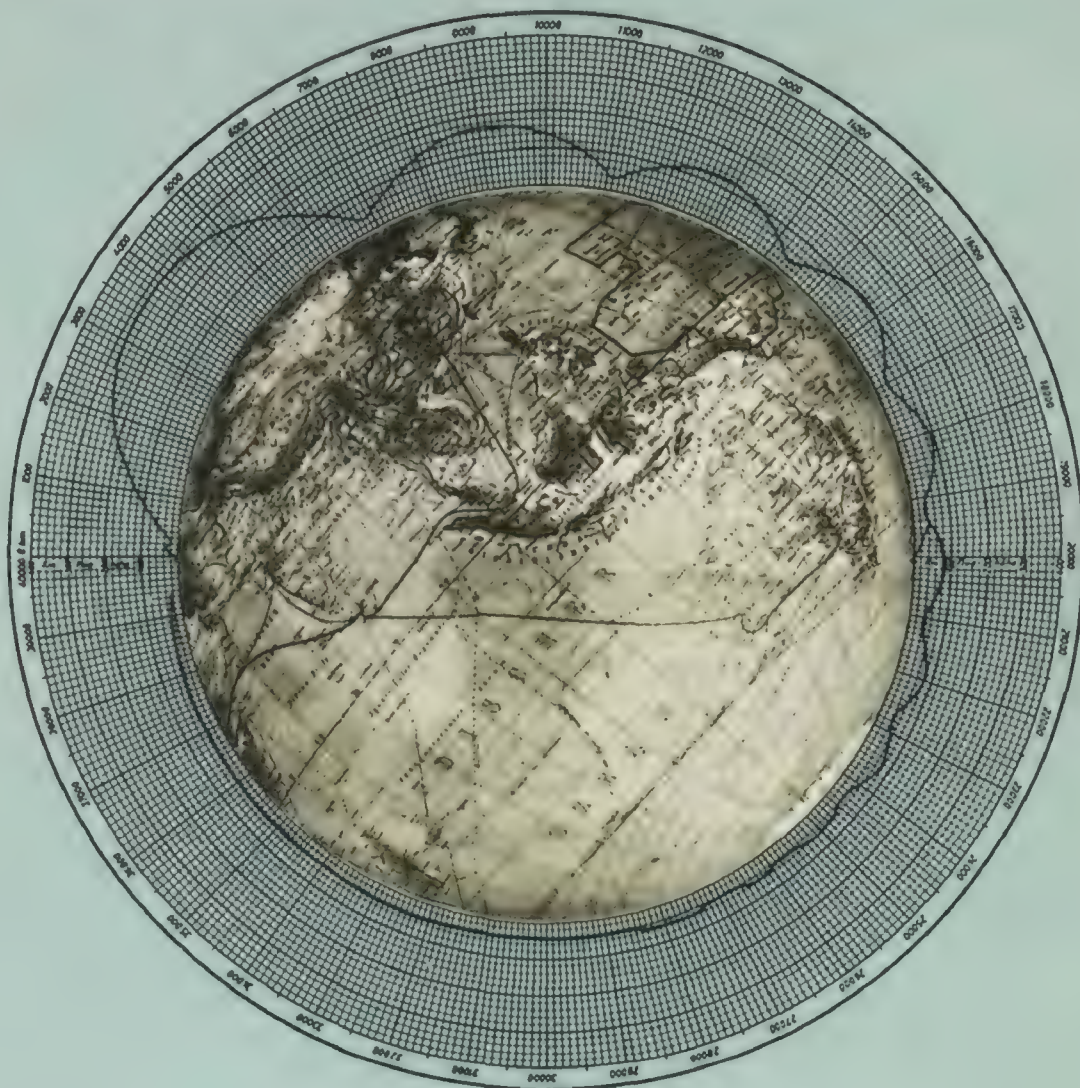
A sewer pipe proved the ramjet principle. Flaming gasoline, fanned at 55 mph, sustained combustion.





The Skip Trajectory of the Amerika Bomber

This diagram, part of Sänger's original proposal, shows the kind of roller coaster path the rocket bomber would travel and the mathematical relationship between altitude and distance. Its launch boosted by a rocket sled, the bomber would burn 90 tons of fuel climbing to an initial height of 174 miles above Earth. Gathering speed as it descended under the pull of gravity, the craft would strike the denser layers of the atmosphere at an altitude of about 25 miles and skip back up. This pattern would be repeated until the height and length of the "hill" diminished and the bomber entered a stable gliding descent back to its point of launch.



Illustrations courtesy of the Sänger Archive

Late in 1943, Sänger and Bredt experimented with ramjets under the auspices of the German Glider Research Institute in Ainring, Bavaria. In February 1945, as the Reich disintegrated, Sänger was at work on the SkP14 ramjet fighter for the Skoda fighter works in Czechoslovakia. Theoretically, this craft would zoom to 60,000 feet in a mere three minutes and fly just under the speed of sound. But it was never built. In May Germany surrendered.

The futuristic nature of Sänger's experiments, a handicap during the war, turned into an advantage at war's end. Sänger and Bredt were interrogated by the Allies, who apparently did not discern the threat the two might once have posed, and were eventually released. There was no work for them in Germany. Even if the war had not devastated the German economy, the Allies had forbidden aerospace research there. But the French Air Ministry was keen on the development of supersonic flight and invited the pair to continue

their ramjet work in France.

Denied access to their previous work, Sänger and Bredt had to go back to basics. In June 1948, on a highway near Montlhéry, they once again started tests with a ramjet pipe mounted on the back of a truck. Their work kept them in France until 1954.

During this time, Sänger and Bredt married (Sänger had divorced his first wife after moving to Germany). Their son, Hartmut, was born in 1952. While they were living a quiet life in Paris, copies of the Amerika Bomber proposal, now known as "the Sänger Report," were circulating among the military organizations of various governments. A Soviet rocket expert, Grigory Tokaev, who defected to England after the war, recounted the Russian reaction to it in an installment of his memoirs published by the London *Daily Express*. According to Tokaev, who had been summoned by Stalin in April 1947 to explain the contents of the report, the Russians were not satisfied with the V-

2's capability—they wanted missiles with longer ranges. "Do you think we are going to fight *Poland*?" Politburo member G.M. Malenkov reportedly growled during the briefing.

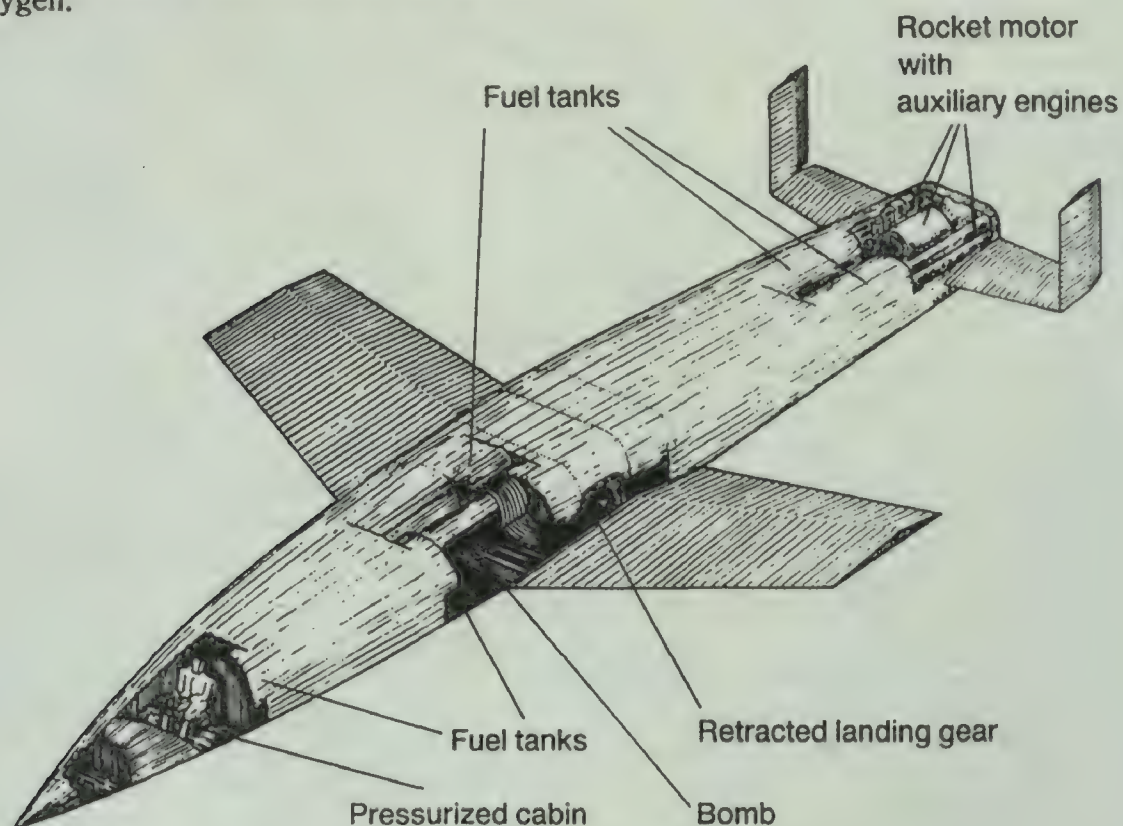
Many years later, Sänger discovered that the French Intelligence had saved him from being kidnapped by Stalin, who had become convinced of the value of Sänger's Amerika Bomber.

When the Allies waived their restrictions on aerospace research in 1954 and the economic and political situation in Germany stabilized, Sänger and his family returned, this time to Stuttgart, where Sänger was invited to build an institute for aerospace propulsion research. He also established the new West German Republic's rocket engine test facility in Lampoldshausen, which still operates today.

In the postwar years, Sänger became a tireless proponent of an independent space program for Europe. In 1958 he published *Spacetravel—Technology's Elimination of War*, a series of reflec-

Inside the Rocket Plane

Sänger designed a craft that was to have been 91.8 feet long with a wingspan of 49.2 feet. Behind the cockpit, two 60-foot-long tanks would hold fuel and liquid oxygen.



MBB



Sänger's 1961 design for a space transport system was the culmination of his life's work with rocket and ramjet engines. Like the one-stage rocket plane of the 1940s, the two-stage Sänger I (above) would have a rocket-assisted launch and would glide back to Earth. In Sänger II, now being developed by the MBB Space Systems Group, the first stage, equipped with air-breathing turbo-ramjets, will carry the second stage to an altitude of approximately 20 miles. The rocket-powered second stage will then be released and will ascend to an orbit about 300 miles above Earth.

tions on the ever-growing importance of technology and the responsibility of the scientific elite. Weapon-weary and fed up with political priorities, Sänger urged politicians to reduce tensions so that space exploration could replace war as the driving force of technology.

His ambitions for European autonomy in space were intensified by a visit to the United States in February 1961. During a stop at Marshall Space Flight Center in Huntsville, Alabama, his former rival, Wernher von Braun, demonstrated the enormous Saturn V engines that would soon power the Apollo flights.

When Sänger returned home in May, he continued to press Europe toward cooperation in space technology. On May 25, President Kennedy announced the start of Project Apollo, and on September 21, the 86-member industrial consortium Eurospace was formed.

Sänger's own vision of Europe's future in space took the form of an aerospace plane for the Junkers aircraft

company in Germany. A new Silverbird was taking shape, and his final proposal depicted a reusable two-stage vehicle in which both stages would glide back to Earth. A steam rocket catapult would assist the launch of the 180-ton craft. Its 2.5-ton payload would orbit Earth at 200 miles. Had the technology been available, his aerospace plane would have incorporated a more powerful rocket engine in combination with an air-breathing ramjet in a single-stage-to-orbit vehicle similar to the U.S. "Orient Express." (See "Space Plane," August/September 1986.)

In 1963 Eurospace approved Sänger's design and appointed him to head its space transportation division. It was his finest hour. Thirty years after having sought an academic post for space research, Sänger was invited to establish Germany's first faculty for space research in Berlin. A month later, while supervising a student lecturer at the University in Berlin, Sänger suffered a heart attack and died.

Europe's first aerospace plane died with him; Sänger I was never built.

Before Sänger started work on the aerospace plane, he concluded his revolutionary theoretical work on the still-futuristic photon rocket engines and photon ramjets, which would collect interstellar matter and use it as fuel to rocket through space. In 10 years his thought had progressed from engines that would surpass the speed of sound to those that would approach the speed of light.

Sänger was once again ahead of his time. These theories, which seemed to contradict accepted physics when Sänger published them in the early '60s, are now the basis of designs that will probably be realized in the 21st century.

Perhaps Sänger's 1958 book on space technology will prove as prophetic. In it he wrote, "Thanks to the development of space technology . . . mankind will soon stand before the great dilemma of having to declare war not only morally, but technically, ridiculous." —

Three If by Air...

Seen from the outside, it is a wistful place, located in a large empty parking lot next to an even larger empty lot that surrounds the Vehicle Maintenance Shop of Kirtland Air Force Base in Albuquerque, New Mexico. Across the street is a shabby one-story building that houses the Air Force Contract Management Division and, in one of those inexplicable management juxtapositions, the Interservice Nuclear Weapons School as well as a credit union. All the surrounding buildings are tan or pink, and dingy. It's not really the sort of place to which one makes a pilgrimage.

The place itself was clearly once a warehouse of some sort, its lower story consisting mostly of garage doors. Now all three stories are painted two shades of tan.

Out front, a pair of Terrier missiles, retired from shipboard duty, feign alertness next to an azure-painted handicapped-parking space. At the entrance of the building is the only graphic stab at style anywhere in sight: running at an angle across the doors in huge bold red and blue letters are the words **national atomic museum**.

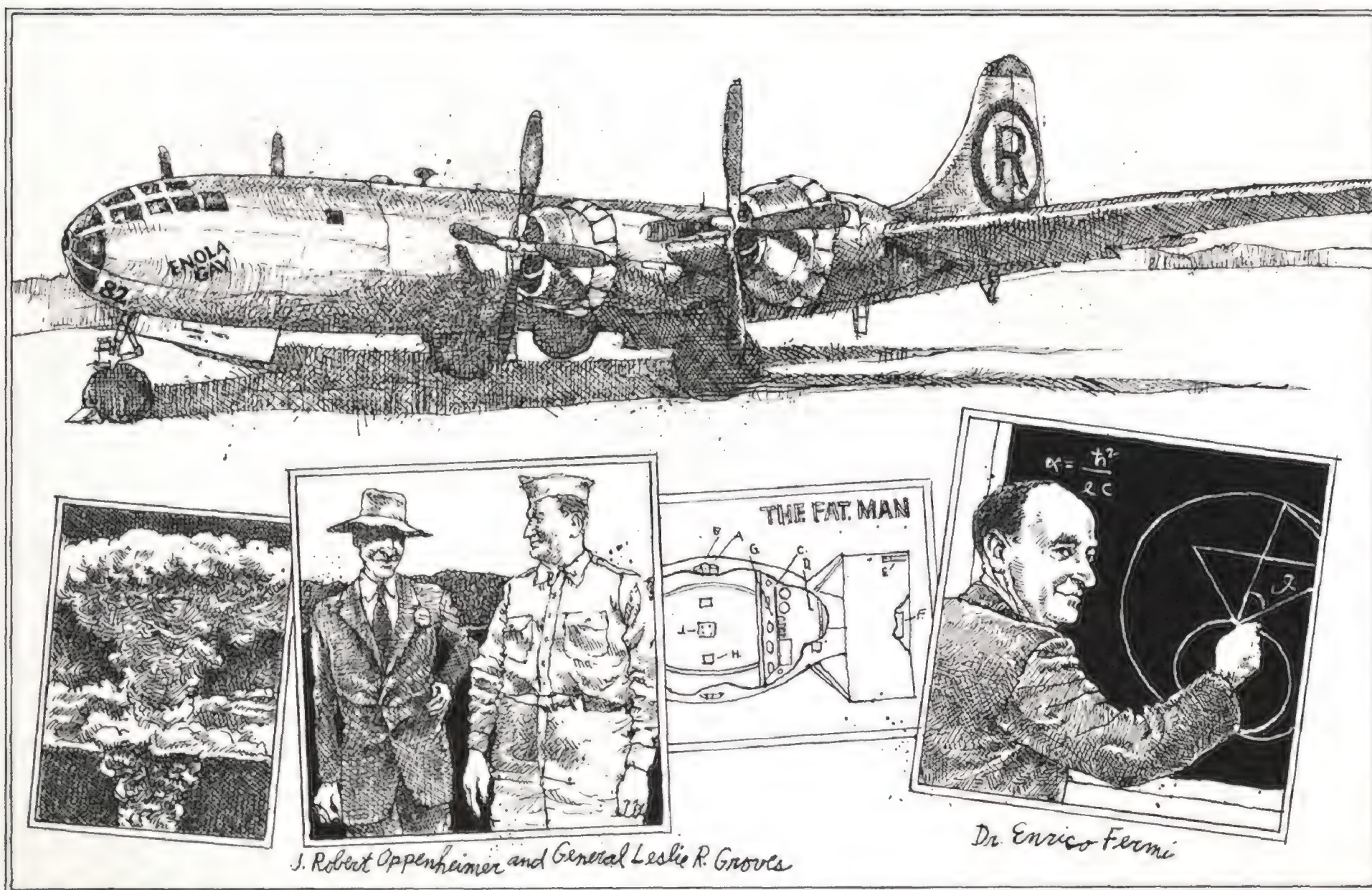
It is open from nine to five every day of the year except New Year's Day, Easter Sunday, Thanksgiving, and Christmas.

Inside, at the kind of information desk common to museums, an elderly lady—a volunteer—is minding the store. She is busy with some papers and doesn't look up. It looks as if few visitors come here to disturb her days. Curious about that, I take a peek at the guest register. I was

preceded here by a man named Wilson Big Crow from Ricon Marquez. He was here yesterday. I have no idea where Ricon Marquez is. If I signed the register, would the next visitor be puzzled that someone turned up here from Virginia?

Inside the museum proper are exhibits showing how nuclear power plants work and a model of the tokamak machine, one of two technologies scientists are betting can produce fusion energy.

But what the National Atomic Museum chiefly—and, in fact, bravely—commemorates is located in another room, the main, warehousy room off to the right, where the walls and garage doors have been painted black to get them out of sight. At Silver Hill in Maryland, the National Air



Illustrations by John L. Heinly

and Space Museum is restoring the *Enola Gay*, favored craft of crossword puzzle makers and the airplane that made history over Hiroshima. I'm struck by the thought that after a half-century of life, all of it spanning the Atomic Age and much of it spent working in museums (including the nation's shrine to aviation in Washington, D.C.), I've never seen the *Enola Gay*. Neither, of course, have I ever seen the singular freight of that famous B-29—that is to say, the central theme of this forlorn little museum.

The first thing that greets me is a bunch of black-and-white photographs and some extended labels, the first of which refers to 5:29 Mountain West Time on July 16, 1945, when mankind saw its first 30,000-foot mushroom cloud. J. Robert Oppenheimer, the man who directed the development of this bomb, was moved to quote from the *Bhagavad-Gita*: "I am become death, the destroyer of worlds."

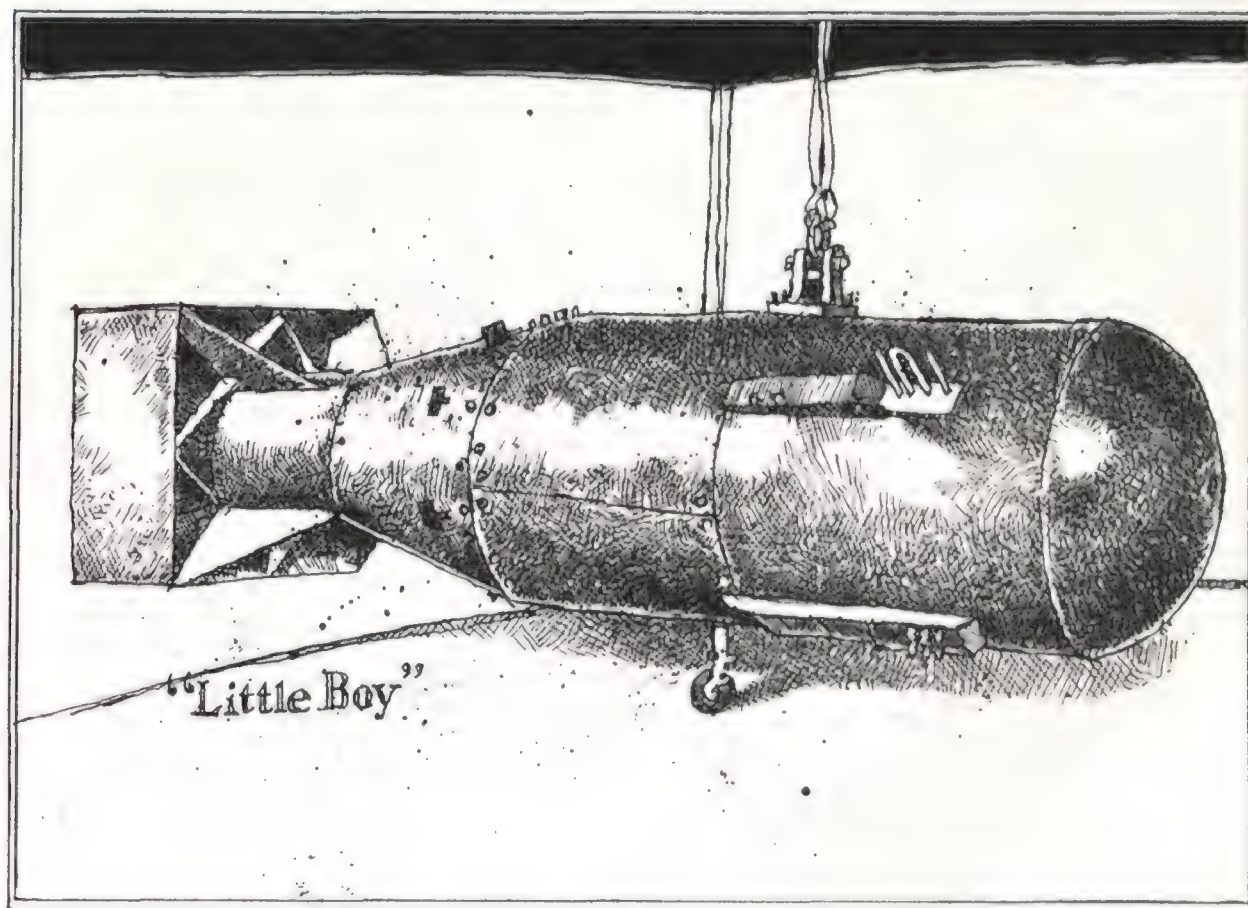
Throughout the photographs, there are the physicists and engineers and technicians, many in double-breasted suits and pleated pants. The grainy black-and-white days of one of physics' greatest moments now seem distant, even quaint.

Next I am confronted by Little Boy. A replica of the *Enola Gay*'s cargo, it is a shiny, dark green, about the same color as the uniform of the U.S. Marines. It is around 10 feet long and 28 inches wide, and were it armed, it would weigh 8,000 pounds—a gun-barrel type of explosive device that brought about 70,000 deaths. It was dropped less than one month after Oppenheimer quoted the Hindus. Little Boy is cold to the touch.

Beyond sits a replica of Fat Man. Weighing 10,800 pounds, the bomb delivered 23 kilotons (10 more kilotons than Little Boy) and produced fewer deaths (45,000) three days later at Nagasaki. It was an implosion device, using plutonium-239 surrounded by high explosives. It is almost the same length as Little Boy, but it is absurdly round. Indeed, it is the same shape as a fat man in a comic book. It too is green and cold.

Both of these objects are altogether inert, as innocent-looking as the Wright *Flyer*, the Model T, or the SST. The mind, nevertheless, floods and stalls. Beyond is a replica of the bomb called Mark 6, the derivative of Fat Man that was mass-produced and was kept "in stock" from 1951 to 1962. In stock.

I walk past the Genie, the first air-to-air missile with a nuclear warhead. It is 10 feet long and painted an antiseptic white. The labels do not explain when and why Marine green went out of style and designers opted for white. Whenever the switch in color—



and from bombers to rockets—took place, I wasn't watching. I was growing up as part of Eisenhower's Silent Generation, as they called us—muted teenagers trying to concentrate on the verities of Patti Page and then Elvis and trying (not very successfully) to avoid thinking that you wouldn't see it when it came. Well-to-do parents in places like Westchester, New York, built personal bomb shelters now that high-speed rocketry could bridge "our" oceans in minutes. The idea sank in all too quickly that mastery of the skies had ended the quaint notion of America as fortress. One if by land, two if by sea . . . three if by air?

Near Mike, the thermonuclear bomb set off on October 31, 1952, is a before-and-after photographic exhibit. Eniwetok. Eniwetok was an archipelago of several more or less contiguous islands; in the pictures I see the distant island Elugelab, then—post-Mike—I don't. Out of sight, out of mind. How many people recall the name Elugelab? I've never seen it in a crossword.

Next is an array of black-and-white portraits of a dozen or so men, the key figures in the debate that raged briefly about whether to build a thermonuclear bomb. All of them—those for and those against—look perfectly normal, perfectly sane, though Secretary of Defense Louis Johnson is pictured staring out of the corner of his eyes, like W. C. Fields playing poker.

Was either side crazy?

I turn the corner and walk down the other side of the room, on my way out. The place is littered with missiles and photographs of airplanes carrying missiles

and silos housing missiles. Mastery of the air. There is a modest row of 11-by-14 black-and-white pictures showing the several stages of a nuclear blast, including its great rising column and cloud. There's a familiarity in the cataclysmic event. Easily contained in the 11-by-14 format, such images have little effect on us anymore. You have to think, or, if you can, remember.

Then abruptly I'm near the exit. A few feet beyond is an exuberant sign: COMING SOON—A NEW EXHIBIT !!!

On the way out, I decide not to ask the lady at the desk what the new exhibit will be. Having decided this, I feel rude. So I go to the desk and sign my name in the guest book. No one else has come here today.

As a little boy, I applauded the abrupt end of World War II. It brought my father home from Okinawa, where he and his Marine division were getting ready to hit the beaches of Japan. But the same technology, now so much more potent and so precisely deliverable, threatens my grandsons, who are still too young to be suspicious of the sky.

Still, what sits inert but pregnant in this out-of-the-way museum is surely as much a part of human creativity as any work of art. We probably *should* stare at it from time to time, and lay a hand on Fat Man. It is also, like it nor not, as much a part of all creation as pterodactyls were and eagles are today.

In the empty lot next to the Terrier missiles, my cab arrives. I give the driver my address. From where I am staying, you can't see this museum.

—Jake Page

The Greatest Man in the World

When James Thurber wrote "The Greatest Man in the World" for The New Yorker in 1931, heroic aviators and their courageous exploits were frequently front-page news in the United States. And, as Charles Lindbergh later pointed out in his book The Spirit of St. Louis, reporters hustling for stories about famous fliers weren't always scrupulous about getting the facts. In the case of pilot Jack "Pal" Smurch, newspaper readers in hero-hungry America may have preferred things that way.

Looking back on it now, from the vantage point of 1950, one can only marvel that it hadn't happened long before it did. The United States of America had been, ever since Kitty Hawk, blindly constructing the elaborate petard by which, sooner or later, it must be hoist. It was inevitable that some day there would come roaring out of the skies a national hero of insufficient intelligence, background, and character successfully to endure the mounting orgies of glory prepared for aviators who stayed up a long time or flew a great distance. Both Lindbergh and Byrd, fortunately for national decorum and international amity, had been gentlemen; so had our other famous aviators. They wore the laurels gracefully, withstood the awful weather of publicity, married excellent women, usually of fine family, and quietly retired to private life and the enjoyment of their varying fortunes. No untoward incidents, on a worldwide scale, marred the perfection of their conduct on the perilous heights of fame. The exception to the rule was, however, bound to occur and it did, in July 1937, when Jack ("Pal") Smurch, erstwhile mechanic's helper in a small garage in Westfield, Iowa, flew a secondhand, single-motored Brethren Dragon-Fly III monoplane all the way around the world, without stopping.

Never before in the history of aviation had such a flight as Smurch's ever been dreamed of. No one had even taken seriously the weird floating auxiliary gas tanks, invention of the mad New Hampshire professor of astronomy, Dr.

Charles Lewis Gresham, upon which Smurch placed full reliance. When the garage worker, a slightly built, surly, unprepossessing young man of twenty-two, appeared at Roosevelt Field in early July 1937, slowly chewing a great quid of scrap tobacco, and announced, "Nobody ain't seen no flyin' yet," the newspapers touched briefly and satirically upon his projected 25,000-mile flight. Aeronautical and automotive experts dismissed the idea curtly, implying that it was a hoax, a publicity stunt. The rusty, battered, secondhand plane wouldn't go. The Gresham auxiliary tanks wouldn't work. It was simply a cheap joke.

Smurch, however, after calling on a girl in Brooklyn who worked in the flap-folding department of a large paper-box factory, a girl whom he later described as his "sweet patootie," climbed nonchalantly into his ridiculous plane at dawn of the memorable seventh of July 1937, spit a curve of tobacco juice into the still air, and took off, carrying with him only a gallon of bootleg gin and six pounds of salami.

When the garage boy thundered out over the ocean the papers were forced to record, in all seriousness, that a mad, unknown young man—his name was variously misspelled—had actually set out upon a preposterous attempt to span the world in a rickety, one-engined contraption, trusting to the long-distance refueling device of a crazy schoolmaster. When, nine days later, without having stopped once, the tiny plane appeared above San Francisco Bay, headed for New York, spluttering and choking, to be sure, but still magnificently and miraculously aloft, the headlines, which long since had crowded everything else off the front page—even the shooting of the governor of Illinois by the Vileti gang—swelled to unprecedented size, and the news stories began to run to twenty-five and thirty columns. It was noticeable, however, that the accounts of the epoch-making flight touched rather lightly upon the aviator himself. This was not because facts about the hero as a man were too meagre, but because they were too complete.

Reporters, who had been rushed out to Iowa when Smurch's plane was first sighted over the little French coast town of Serly-le-Mer, to dig up the story of the great man's life, had promptly discovered that the story of his life could not be printed. His mother, a sullen short-order cook in a shack restaurant on the edge of a tourists' camping ground near Westfield, met all inquiries as to her son with an angry "Ah, the hell with him; I hope he drowns." His father appeared to be in jail somewhere for stealing spotlights and lap robes from tourists' automobiles; his young brother, a weak-minded lad, had but recently escaped from the Preston, Iowa, Reformatory and was already wanted in several Western towns for the theft of money-order blanks from post offices. These alarming discoveries were still piling up at the very time that Pal Smurch, the greatest hero of the twentieth century, bleary-eyed, dead for sleep, half-starved, was piloting his crazy junk-heap above the region in which the lamentable story of his private life was being unearthed, headed for New York, and a greater glory than any man of his time had ever known.

The necessity for printing some account in the papers of the young man's career and personality had led to a remarkable predicament. It was of course impossible to reveal the facts, for a tremendous popular feeling in favor of the young hero had sprung up, like a grass fire, when he was halfway across Europe on his flight around the globe. He was, therefore, described as a modest chap, taciturn, blond, popular with his friends, popular with girls. The only available snapshot of Smurch, taken at the wheel of a phony automobile in a cheap photo studio at an amusement park, was touched up so that the little vulgarian looked quite handsome. His twisted leer was smoothed into a pleasant smile. The truth was, in this way, kept from the youth's ecstatic compatriots; they did not dream that the Smurch family was despised and feared by its neighbors in the obscure Iowa town, nor that the hero himself, because of numerous unsavory exploits, had come to be regarded in Westfield as a



nuisance and a menace. He had, the reporters discovered, once knifed the principal of his high school—not mortally, to be sure, but he had knifed him; and on another occasion, surprised in the act of stealing an altarcloth from a church, he had bashed the sacristan over the head with a pot of Easter lilies; for each of these offences he had served a sentence in the reformatory.

Inwardly, the authorities, both in New York and in Washington, prayed that an understanding Providence might, however awful such a thing seemed, bring disaster to the rusty, battered plane and its illustrious pilot, whose unheard-of flight had aroused the civilized world to hosannas of hysterical praise. The authorities were convinced that the character of the renowned aviator was such that the limelight of adulation was bound to reveal him to all the world as a congenital hooligan mentally and morally unequipped to cope with his own prodigious fame. "I trust," said the secretary of state, at one of many secret Cabinet meetings called to consider the national dilemma, "I trust that his mother's prayer will be answered," by which he referred to Mrs. Emma Smurch's wish that her son might be drowned. It was, however, too late for that—Smurch had leaped the Atlantic and then the Pacific as if they were millponds.

At three minutes after two o'clock on the afternoon of July 17, 1937, the garage boy brought his idiotic plane into Roosevelt Field for a perfect three-point landing.

It had, of course, been out of the question to arrange a modest little reception for the greatest flier in the history of the world. He was received at Roosevelt with such elaborate and pretentious ceremonies as rocked the world. Fortunately, however, the worn and spent hero promptly swooned, had to be removed bodily from his plane, and was spirited from the field without having opened his mouth once. Thus he did not jeopardize the dignity of this first reception, a reception illumined by the presence of the secretaries of war and the navy, Mayor Michael J. Moriarty of New York, the premier of Canada, Governors Fanniman, Groves, McFeely, and Critchfield, and a brilliant array of European diplomats. Smurch did not, in fact, come to in time to take part in the gigantic hullabaloo arranged at City Hall for the next day. He was rushed to a secluded nursing home and confined to bed. It was nine days before he was able to get up, or to be exact, before he was permitted to get up. Meanwhile the greatest minds in the country, in solemn assembly, had arranged a secret conference

of city, state, and government officials, which Smurch was to attend for the purpose of being instructed in the ethics and behavior of heroism.

On the day that the little mechanic was finally allowed to get up and dress and, for the first time in two weeks, took a great chew of tobacco, he was permitted to receive the newspapermen—this by way of testing him out. Smurch did not wait for questions. "Youse guys," he said—and the *Times* man winced—"youse guys can tell the cockeyed world dat I put it over on Lindbergh, see? Yeh—an' made an ass o' them two frogs." The "two frogs" was a reference to a pair of gallant French fliers who, in attempting a flight only halfway round the world, had, two weeks before, unhappily been lost at sea. The *Times* man was bold enough, at this point, to sketch out for Smurch the accepted formula for interviews in cases of this kind; he explained that there should be no arrogant statements belittling the achievements of other heroes, particularly heroes of foreign nations. "Ah, the hell with that," said Smurch. "I did it, see? I did it, an' I'm talkin' about it." And he did talk about it.

None of this extraordinary interview was, of course, printed. On the contrary, the newspapers, already under the disciplined direction of a secret directorate



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created for the occasion and composed of statesmen and editors, gave out to a panting and restless world that "Jacky," as he had been arbitrarily nicknamed, would consent to say only that he was very happy and that anyone could have done what he did. "My achievement has been, I fear, slightly exaggerated," the *Times* man's article had him protest, with a modest smile. These newspaper stories were kept from the hero, a restriction which did not serve to abate the rising malevolence of his temper. The situation was, indeed, extremely grave, for Pal Smurch was, as he kept insisting, "rarin' to go." He could not much longer be kept from a nation clamorous to lionize him. It was the most desperate crisis the United States of America had faced since the sinking of the *Lusitania*.

On the afternoon of the twenty-seventh of July, Smurch was spirited away to a conference room in which were gathered mayors, governors, government officials, behaviorist psychologists, and editors. He gave them each a limp, moist paw and a brief unlovely grin. "Hah ya?" he said. When Smurch was seated, the mayor of New York arose and, with obvious pessimism, attempted to explain what he must say and how he must act when presented to the world, ending his talk with a high tribute to the hero's courage and integrity. The mayor was followed by Governor Fanniman of New York, who, after a touching declaration of faith, introduced Cameron Spottiswood, Second Secretary of the American Embassy in Paris, the gentleman selected to coach Smurch in the amenities of public ceremonies. Sitting in a chair, with a soiled yellow tie in his hand and his shirt open at the throat, unshaved, smoking a rolled cigarette, Jack Smurch listened with a leer on his lips. "I get ya, I get ya," he cut in, nastily. "Ya want me to ack like a softy, huh? Ya want me to ack like that — — —

— — — baby-faced Lindbergh, huh? Well, nuts to that, see?" Everyone took in his breath sharply; it was a sigh and a hiss. "Mr. Lindbergh," began a United States senator, purple with rage, "and Mr. Byrd—" Smurch, who was paring his nails with a jackknife, cut in again. "Byrd!" he exclaimed. "Aw fa God's sake, dat big—" Somebody shut off his blasphemies with a sharp word. A newcomer had entered the room. Everyone stood up, except Smurch, who, still busy with his nails, did not even glance up. "Mr. Smurch," said someone sternly, "the President of the United States!" It had been thought that the presence of the chief executive might have a chastening effect upon the young hero, and the former had been, thanks to the

remarkable cooperation of the press, secretly brought to the obscure conference room.

A great, painful silence fell. Smurch looked up, waved a hand at the President. "How ya comin'?" he asked, and began rolling a fresh cigarette. The silence deepened. Someone coughed in a strained way. "Geez, it's hot, ain't it?" said Smurch. He loosened two more shirt buttons, revealing a hairy chest and the tattooed word "Sadie" enclosed in a stenciled heart. The great and important men in the room, faced by the most serious crisis in recent American history, exchanged worried frowns. Nobody seemed to know how to proceed. "Come awn, come awn," said Smurch. "Let's get the hell out of here! When do I start cuttin' in on de parties, huh? And what's they goin' to be *in* it?" He rubbed a thumb and forefinger together meaningly. "Money!" exclaimed a state senator, shocked, pale. "Yeh, money," said Pal, flipping his cigarette out of a window. "An' big money." He began rolling a fresh cigarette. "Big money," he repeated,



frowning over the rice paper. He tilted back in his chair, and leered at each gentleman, separately, the leer of an animal that knows its power, the leer of a leopard loose in a bird-and-dog show. "Aw fa God's sake, let's get some place where it's cooler," he said. "I been cooped up plenty for three weeks!"

Smurch stood up and walked over to an open window, where he stood staring down into the street, nine floors below. The faint shouting of newsboys floated up to him. He made out his name. "Hot dog!" he cried, grinning, ecstatic. He leaned out over the sill. "You tell 'em, babies!" he shouted down. "Hot diggity dog!" In the tense little knot of men standing behind him, a quick, mad impulse flared up. An unspoken word

of appeal, of command, seemed to ring through the room. Yet it was deadly silent. Charles K.L. Brand, secretary to the mayor of New York City, happened to be standing nearest Smurch; he looked inquiringly at the President of the United States. The President, pale, grim, nodded shortly. Brand, a tall, powerfully built man, once a tackle at Rutgers, stepped forward, seized the greatest man in the world by his left shoulder and the seat of his pants, and pushed him out the window.

"My God, he's fallen out the window!" cried a quick-witted editor.

"Get me out of here!" cried the President. Several men sprang to his side and he was hurriedly escorted out of a door toward a side entrance of the building. The editor of the Associated Press took charge, being used to such things. Crisply he ordered certain men to leave, others to stay; quickly he outlined a story which all the papers were to agree on, sent two men to the street to handle that end of the tragedy, commanded a senator to sob and two congressmen to go to pieces nervously. In a word, he skillfully set the stage for the gigantic task that was to follow, the task of breaking to a grief-stricken world the sad story of the untimely, accidental death of its most illustrious and spectacular figure.

The funeral was, as you know, the most elaborate, the finest, the solemnest, and the saddest ever held in the United States of America. The monument in Arlington Cemetery, with its clean white shaft of marble and the simple device of a tiny plane carved on its base, is a place for pilgrims, in deep reverence, to visit. The nations of the world paid lofty tributes to little Jacky Smurch, America's greatest hero. At a given hour there were two minutes of silence throughout the nation. Even the inhabitants of the small, bewildered town of Westfield, Iowa, observed this touching ceremony; agents of the Department of Justice saw to that. One of them was especially assigned to stand grimly in the doorway of a little shack restaurant on the edge of the tourists' camping ground just outside the town. There, under his stern scrutiny, Mrs. Emma Smurch bowed her head above two hamburger steaks sizzling on her grill—bowed her head and turned away, so that the Secret Service man could not see the twisted, strangely familiar, leer on her lips.

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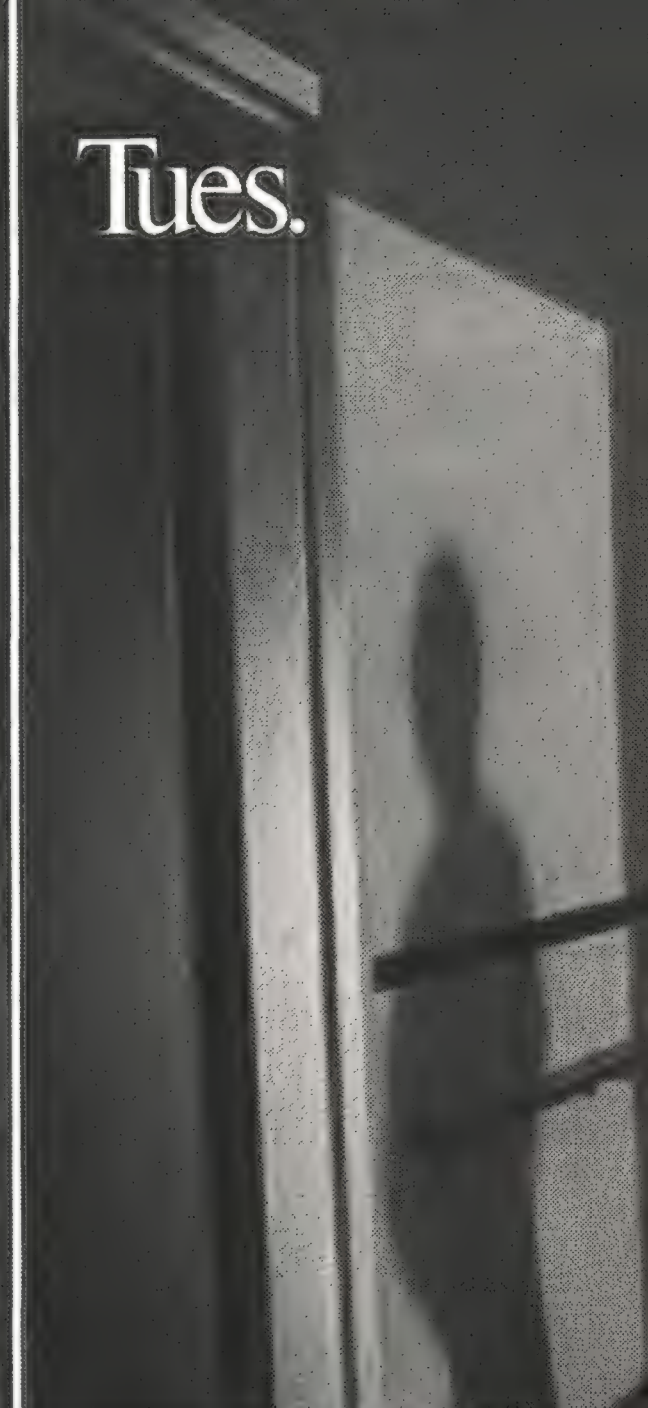
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Reviews(&Previews

Women of the Air. By Judy Lomax. Dodd, Mead & Co., 1986, 1987. 216 pp., b&w photographs, \$15.95 (hardbound).

"It would seem that a woman's success in any particular line would prove her fitness for that work, without regard to theories to the contrary." —*Ruth Law*

Flying is "more thrilling than love for a man and far less dangerous."
—*Thea Rasche*

"If enough of us keep trying, we'll get someplace." —*Amelia Earhart*

These quotations epitomize the themes put forward by Judy Lomax in her compilation of short biographies of female aviators. Lomax for the most part allows the women to speak for themselves; the book's bibliography indicates that much of the material in *Women of the Air* is based on autobiographies.

This approach works very well. Rather than trotting out long lists of dates, records, and statistics, Lomax offers us a look into the backgrounds and personal lives of an intriguing group of women. Not all of it is pleasant, either. We read, for instance, of Amy Johnson's erratic pursuit of a career, the eventual recognition of her skills as a pilot following her solo flight to Australia, and, at the height of her success, her disastrous marriage to the alcoholic and unfaithful John Mollison.

On a lighter note, Lomax brings to life the exciting and now somewhat comic-seeming early days of aviation, particularly the pioneering days of ballooning. Especially colorful is the story of Dolly Shepherd, who, after a half-hour's training, became a parachutist from balloons with a troupe led by the popular Edwardian-era balloonist Auguste Gaudron. She was billed as "the Parachute Queen" for eight years until, during a jump in 1912, "she heard a warning voice: 'Don't come up again or you'll be killed.'" She heeded that inner voice and lived to age 96.

Chapters on Jacqueline Auriol of France and Hanna Reitsch of Germany include



Actress Ruth Elder flew at a time when men were pilots and women were props.

interesting insights and anecdotes. Both women survived near-fatal air accidents and subsequently continued their record-breaking careers. Both, too, were criticized for their political loyalties: Auriol because her lifestyle seemed unduly extravagant for a daughter-in-law of the president of France; Reitsch for her admiration of Hitler. Yet through it all they never lost their devotion to aviation, their love of flying. This is brought out most strongly by the titles of their autobiographies: Auriol's *I Live to Fly* and Reitsch's *Flying Is My Life*.

Lomax also brings to our attention the stories of several colorful but obscure women, England's "flying aristocrats": Lady Mary Heath, Lady Mary Bailey, the Duchess of Bedford, and the Honorable Mrs. Victor Bruce. Bruce had been flying only a few weeks in 1930 when she set out around the world. (But when it was necessary to cross the Atlantic and Pacific, she had sense enough to send her aircraft by ship.) Throughout the book, Lomax's easy, flowing, readable style allows the women to shine through.

Unfortunately, many glaring errors of fact mar what would otherwise be a good addition to the literature on women in aviation. For instance, the duration of Earhart's 1928 flight across the Atlantic as a passenger is given in the text as 40 hours, 20 minutes, when the bibliography correctly cites Earhart's first book, her account of that flight, entitled *20 Hrs. 40 Mins.* Also, Lomax states several times

that John Alcock and Arthur Whitten-Brown were the first to fly across the Atlantic; in fact, they were preceded by two weeks by the U.S. Navy's Curtiss NC-4.

The chapter on Jacqueline Cochran likewise suffers from misstatements. Cochran started the 1934 MacRobertson Race not in a Northrop Gamma but in the Granville Brothers racer, the Gee Bee Q.E.D. (the only original Gee Bee racer that survives today). Besides diminishing the book's credibility, the error deprives readers of the knowledge that Cochran was one of the very few women who ever flew Gee Bee racers. In addition, Cochran's victory in the 1938 Bendix Trophy race was the second time, not the first, that the race had been won by a woman: two years earlier, Louise Thaden and copilot Blanche Noyes had become the first women to win that prestigious transcontinental air race. These errors are not the only ones the book contains.

For the general reader, this book is an entertaining and pleasant survey of women who have made places for themselves in a traditionally male-dominated profession. It is sad that a number of factual errors prevent full enjoyment of a work that has much potential.

—*Claudia M. Oakes is a curator in the Aeronautics Department at the National Air and Space Museum. Her main field of interest is women in aviation. She writes and lectures frequently on the subject.*

From Huffman Prairie to the Moon: The History of Wright-Patterson Air Force Base. By Lois E. Walker and Shelby E. Wickam. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, 1986. 496 pp., b&w and color photographs and illustrations, \$28.50 (hardbound).

It used to be that when one thought of the frontiers of flight, of daring test pilots and flight test engineers probing the unknown, one name naturally came to mind: Wright Field. Located a few miles east of Dayton,

Ohio, near the banks of the Mad River and the legendary Huffman Prairie, where Wilbur and Orville's creations took to the sky, "the Field" stood for everything that was progressive, innovative, and professional in aeronautical development. Here the technology base that won the second world war was built. Here visionary engineers such as Ezra Kotcher conceptualized the supersonic era. Here flourished an atmosphere of innovation and inquiry typified by the Air Corps Engineering School (now the Air Force Institute of Technology) and the various laboratories that now form a complex known as AFWAL: the Air Force Wright Aeronautical Laboratories.

Today, the Air Force has myriad research centers, laboratories, and offices located nationwide, all pursuing work that the pioneers of Wright Field would have appreciated. Nevertheless, Wright-Patterson Air Force Base is still as vital to the national pursuit of aerospace science and technology as its predecessor, Wright Field, was long ago.

In *From Huffman Prairie to the Moon*,

NASM



The 1921 de Bothezat helicopter worked, but not well enough to inspire any orders.

Lois Walker and Shelby Wickam, professional historians working for the Air Force Logistics Command, tell the Wright-Patterson story in a grand style, generously illustrated with rare photographs. It is as definitive a history of this crucial site as is likely to appear.

The story of Wright-Patterson really begins long before the creation of the Air Force. Between visits to Kitty Hawk, the brothers Wright tested their craft on the flat expanse of Huffman Prairie. Wilbur died in 1912 of typhoid fever, and when the United States entered the War to End All Wars in 1917, the Army established a field near the Prairie and named it in his honor. At the same time, the service opened another major facility near Dayton, known as McCook Field. This site became the Edwards of its day—the nation's first well-planned, comprehensive flight testing and research center.

In 1927 the service dedicated the "new" Wright Field in festivities presided over by Orville Wright himself. The 1920s and 1930s was a time of intensive aeronautical development at first McCook and later Wright Fields, and Walker and Wickam do this period full justice, covering such events as the 1924 Around-the-World Flight by the Army's Douglas World Cruisers and the flight testing and analysis of a number of influential and not-so-influential types such as the ungainly but well-known Barling bomber, the de Bothezat helicopter, the Martin B-10 bomber, and the Curtiss P-36 Hawk. This is a rich dish, and there is material enough to satisfy aircraft buffs, students of military administration, and scholars tracing the management of science and technology in a military context. Throughout, the authors write with style and clarity.

The sections on the war and postwar years will probably attract the interest of most readers, and woven into this portion is the story of Patterson Field, originally the part of Wright Field east of Huffman Dam. Although Patterson never matched Wright in popularity, it is today the home of the Air Force Logistics Command and the "flying" side of the Wright-Patterson Air Force Base complex: instrument-heavy C-130s, C-135s, and C-141s of the 4950th Test Wing take off from Patterson on research-and-development support missions around the globe, and the hulking F-4 "Rhinos" of the 906th Tactical Fighter Group enliven weekends with the glare of afterburners and the roar of raw power.

The base's old "Area B"—the original Wright Field—is now the site of the Air Force Museum, and the aircraft parked in a row outside the museum seem perfectly at home next to the original hangars and laboratory facilities that served the nation so well in the 1930s, through World War II, and into the Space Age.

This meticulous book does an excellent job of conveying both the old and the new of Wright-Patterson's history.

—Richard P. Hallion is the Harold Keith Johnson visiting professor of military history at the Military History Institute, Carlisle Barracks, Pennsylvania.

The Space Station: A Personal Journey. By Hans Mark. Duke University Press, 1987. 264 pp., b&w illustrations and photographs, \$24.95 (hardbound).

Hans Mark is an important figure in the history of the U.S. space program: over the past two decades, he has played critical roles in both the space shuttle and space

station projects. He served as head of the National Aeronautics and Space Administration's Ames Research Center from 1969 to 1977, undersecretary of the Air Force from 1977 to 1979, secretary of the Air Force from 1979 to 1980, and deputy administrator of NASA from 1981 to 1984. This account of his years in government service should appeal to anyone with an interest in the politics of space. There are bound to be some members of the space community who will disagree with Mark's interpretation of events; this is, after all, a memoir, not a history text.

The first 30 pages of *The Space Station: A Personal Journey* cover Mark's studies of nuclear physics at the University of California in Berkeley and the Massachusetts Institute of Technology, his work with physicist Edward Teller, and his first forays into space research at Lawrence Livermore Laboratory. Mark writes that the "awe-inspiring experience" of listening to Apollo astronauts as they circled the moon prodded him to give up research for the job of running the Ames Center in Northern California. In 1977, President Carter's defense secretary, Harold Brown, who had hired Mark at Livermore Lab back in the 1950s, offered Mark the job of Air Force undersecretary, with primary responsibility for Air Force space programs. In this position, and later as secretary of the Air Force, Mark worked closely with NASA on shuttle planning.

In explaining how he made the transition from the Carter to the Reagan administration, Mark tells a rather interesting anecdote: In July 1980, Hughes Aircraft official Albert Wheelon asked Mark if he would be willing to give a briefing on the shuttle program to a group of Reagan campaign managers. Mark had doubts about Carter's chances for a second term, so he said yes. "I did not tell Harold Brown that I was going to see some of Governor Reagan's people because I feared being told that I could not talk to them. I felt badly about this, but I did not know what else to do . . . I salvaged my conscience by writing out a letter of resignation that I resolved to send to Brown in the event that President Carter won reelection. As things turned out, I could have saved myself the trouble since I would be relieved of my post in due course." Wheelon was one of many friends who helped get Mark into NASA once Reagan moved into the White House.

In detailing his role in the shuttle program, Mark notes that in the beginning he "was not an enthusiastic supporter of the space shuttle . . . My own background in space science had conditioned me to think in terms of unmanned space



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Attila Hejja



The Smithsonian Book of Flight. By Walter Boyne. Smithsonian Books, 1987. 288 pp., b&w and color illustrations and photographs, \$35.00 in bookstores; Associates' edition \$22.95 plus \$2.49 postage and handling (hardbound).

This illustration from the book depicts aviation experimentalist Paul MacCready's design for an ultra-safe light airplane. In this history of flight, Boyne suggests that the future of aviation lies in such personal-use craft.

operations and I felt that the presence of people might actually complicate things." But two things changed his mind: the lifesaving actions of the *Apollo 13* crew after an in-flight explosion, and long talks with rocket builder Wernher von Braun, who explained how the shuttle was necessary to service a space station that ultimately would get the United States back to the moon and beyond. "By the beginning of 1972, I had become a convert," Mark says. And in the mid-1970s, meetings with Gerard K. O'Neill—physics professor, space entrepreneur, and advocate of space colonization—revived Mark's interest in space stations.

Nowadays Mark favors setting up a government corporation to operate the space shuttle, so that NASA can concentrate on research and development. He also endorses close ties between NASA and the defense department. "Contrary to those people who fear the 'militarization' of space or of the shuttle," he writes, military missions in space "are much more likely to contribute to world stability rather than to increase the destructive potential of modern war."

This memoir provides loads of details on the process of making space policy—balancing technical and budgetary considerations with political goals, interagency rivalries, personality conflicts, maneuvering for time with the president, and the formation of the Senior Interagency

Group on Space (SIG Space) in 1982 to oversee space policy making. It also identifies many behind-the-scenes players in the space program, such as James Fanseen, a Reagan campaign advance man who became NASA administrator James Beggs' White House liaison; Cabinet affairs director Craig Fuller, who helped keep space issues prominent at the White House; and Fred Khedouri, an Office of Management and Budget official who was not supportive of NASA's space station proposal. Mark is generous with colleagues whom he profiles, describing most of them as "brilliant" or at least "remarkable."

Mark wrote all but the last chapter of this book before the *Challenger* accident. In the final chapter, he reflects on the tragedy: "I cannot remember a single flight when some group of engineers who were responsible for one or another of the subsystems did not advise us to delay the launch. Sometimes we took their advice and postponed... other times we went ahead and flew in spite of the advice." He writes in closing, "I now regret that I ever left NASA... I do not know whether I could have done anything to prevent the loss of *Challenger* had I stayed... What I know is that, somehow, I should have been there to share the grief and pain with all my friends..."

—Linda Billings, Senior Editor/Space

SOLARQUEST®. Golden/Western Publishing, 1986. Board game, \$12.00.

You've just landed on the Uranian moon Oberon. You have only 200 Federons cash and 11 hydrons of fuel in your spaceship. For 175 Federons you could buy Oberon, install a fuel station there, and refuel. Or, you could risk all on the chance that your next roll will take you to Pluto's satellite, Charon, where you already have a fuel station, or to Uranus' Ariel, where you can buy fuel from your opponent. If only someone would land on your hottest property, Mercury, with its 1035-Federon rent, you'd be all set . . .

That's Solarquest for you. Its manufacturers bill the board game as a "space-age real estate game." Indeed, it bears at least a passing resemblance to a certain terrestrial real estate game: Solarquest players attempt to acquire monopolies on various categories of properties (the moons of a planet, research labs, and space docks) while hoping to avoid landing on an opponent's facilities. When a player rolls doubles, he draws a "Red Shift" card, which gives instructions ranging from "Discover New Comet: Collect 400 Federons" to "Advance to Neptune Research Lab." Meanwhile, the player has to monitor cash flow and fuel consumption: spaceship fuel tanks have only a 25-hydron capacity. On most turns a player will consume as many hydrons of fuel as the number of spaces he advances, so fuel shortages are a constant concern.

The game is not ponderously slow, but it's not any too fast, either. Designed for two to six players, it seems to move along best when played by four.

And, in a painless way, one can even learn from the game. Pronunciation guides are prominently displayed on all the deed cards for planetary satellites, and the cards' flip sides include such celestial trivia as the moons' diameters and orbital periods.

The arrangement of the planets on the playing board is a bit disconcerting: one travels from Earth to Mercury to Jupiter to Uranus, onward to Pluto, Mars, Venus, and Saturn, and finally to Neptune before completing a circuit and returning to Earth. It may have been impossible to arrange the planets on a reasonable-sized playing board in a way that reflected their actual orbital positions; nonetheless, the relationships between the planets suggested by the game's design are somewhat disturbing.

Still, once the surprise of finding Pluto between Mars and Uranus has worn off, one can enjoy whiling away the hours becoming a Space Age real estate tycoon.

—Katie Janssen, Associate Editor

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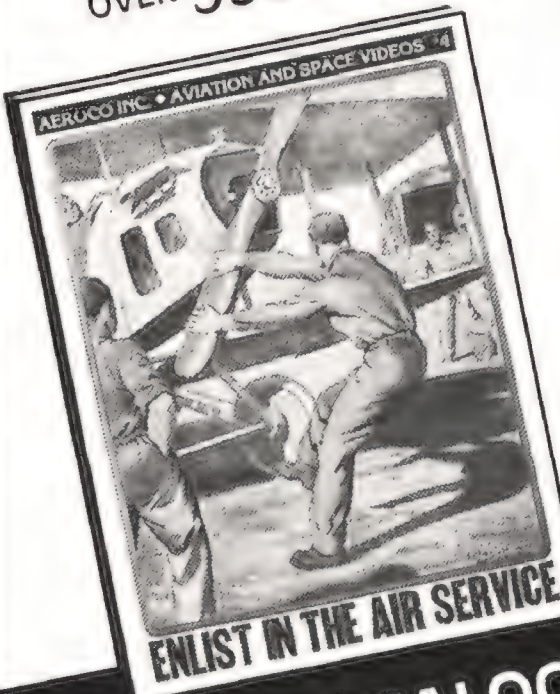


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Credits(&Further Reading

Cover. Freelance illustrator Pierre Mion lives in a restored house in the Virginia countryside. A daredevil of sorts, he used to race sports cars and motorcycles. Presently, he flies sailplanes.

Flight of the Lighthawk. Nancy Shute is a student pilot who frequently writes on conservation issues. Her last feature in *Air & Space/Smithsonian*, "Homemade Satellites," appeared in the December 1986/January 1987 issue.

George H.H. Huey, best known for his landscape and wildlife photography on the ground, took to the air with Project Lighthawk.

Further information: To contact Project Lighthawk, write to P.O. Box 8163, Santa Fe, NM 87504 or call (505) 982-9656.

Farsighted Astronomers. A freelance writer based in Norfolk, Virginia, Marcia Bartusiak is the author of *Thursday's Universe*, a layman's guide to the frontiers of astrophysics that was recently selected as an astronomy book of the year by the Astronomical Society of the Pacific. As one of the 40 finalists in NASA's journalist-in-space program, Bartusiak hopes to get closer to those distant galaxies.

Further information: *Thursday's Universe*, Marcia Bartusiak, Times Books, New York, 1986.

"The Most Distant Known Galaxies," Richard G. Kron, *Science*, vol. 216, no. 4543, April 16, 1982.

"The Evolution of Galaxies in Clusters," A. Dressler, *Annual Review of Astronomy and Astrophysics*, vol. 22, 1984.

The Go Team. William Triplett is a Washington, D.C.-based freelance writer specializing in aviation and, in his own words, "pop-cultural phenomena." An Air Force brat, he has been writing about various aspects of air accident investigations since 1984.

Further information: To purchase NTSB summaries of air accident reports, write to National Technical Information Service, Springfield, VA 22161 or call (703) 487-4650.

For copies of NTSB annual reports to Congress, write to NTSB, Office of Government and Public Affairs, 800 Independence Avenue SW, Washington, DC 20594.

Disaster Detectives, Louis Wolfe, Simon & Schuster, New York, 1981.

Safety Is No Accident, W. Tench, Collins, London, 1985. (An insider's account of aviation accident investigation in the United Kingdom.)

Essay: Law of the Next Frontier.

George S. Robinson has practiced space law in Washington, D.C., for the past 25 years.

Appointment at Big Kill Devil Hill.

Charles E. Little, a Washington, D.C.-based writer specializing in natural resources and geographical topics, wrote "Professor Lewis's Doughnuts" for the inaugural issue of *Air & Space/Smithsonian* (April/May 1986). His most recent book, *Green Fields Forever*, was published this spring by Island Press.

Paul Salmon is a freelance illustrator who lives and works in Burke, Virginia.

Further information: *Wind and Sand: The Story of the Wright Brothers at Kitty Hawk*, Lyanne Wescott and Paula Degen, Harry N. Abrams, Inc., New York, 1983.

A Dream of Wings: Americans and the Airplane, 1875-1905, Tom D. Crouch, W.W. Norton and Co., New York, 1981.

Islands, Capes, and Sounds: The North Carolina Coast, Thomas J. Schoenbaum, John F. Blair, Winston-Salem, NC, 1982.

Getting off the Fence. Richard Sassaman, of Bar Harbor, Maine, travels widely in the United States researching American history and customs. He has a special interest in the Wright brothers.

The World on \$52,200 a Day. Michael Rozek's articles have appeared in many national magazines, including *Sports Illustrated*, *Esquire*, and *Air & Space/Smithsonian*. He lives in Spokane, Washington.

Further information: To contact Society Expeditions, write to 3131 Elliott Avenue,

"The Satellite Sky" Update /2

These regular updates to "The Satellite Sky" chart will enable readers to keep their charts up to date. Additions can be clipped and affixed to the chart at the appropriate altitude.

New launches

90 to 300 MILES



Cosmos 1836
4-87 TT



Progress 30
5-87 TT (supply)



Cosmos 1847
5-87 PL



Cosmos 1848
5-87 PL

300 to 630 MILES



Cosmos 1842
4-87 PL



Cosmos 1844
5-87 TT



Cosmos 1850
6-87 PL

630 to 1,250 MILES



White Cloud
5-87 VAFB

21,750 to 22,370 MILES



Gorizont 14
5-87 TT

Deletion

90 to 300 MILES

Cosmos 1835
down 6-4-87

Inoperative but still in orbit

300 to 630 MILES 630 to 1,250 MILES

Meteor 2-11
Cosmos 1500
Cosmos 1624
Cosmos 1680
Cosmos 1570

White Cloud
(6-83 Version Only)
Ferret
Cosmos 1617-22
Cosmos 1635-42

Launched but not in orbit

90 to 300 MILES

Progress 29 USSR supply	4-21-87	down 5-11-87
Cosmos 1837 USSR recon	4-22-87	down 4-28-87
Cosmos 1841 USSR science	4-24-87	down 5-8-87
Cosmos 1843 USSR recon	5-5-87	down 5-19-87
Cosmos 1845 USSR recon	5-13-87	down 5-27-87
Cosmos 1846 USSR recon	5-21-87	down 6-4-87

Correction to last issue's Update:

The three satellite deletions should have been made from the 6,200-13,700 mile band rather than the 630-1,250 mile band.

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(206) 285-9400.

Mars Swiftly. Ken Croswell is a graduate student at Harvard University. He has written for *Astronomy*, *Odyssey*, *Space World*, and *Star Date*.

Further information: "Phobos and Deimos," *Astronomy*, vol. 5, no. 3, March 1977.

"Who Told Jonathan Swift About the Moons of Mars?" *Griffith Observer*, vol. 44, no. 7, July 1980.

The Birdman of Queens. John Grossmann is a freelance writer who lives in Pennsylvania. His work has appeared in *Smithsonian*, *Esquire*, the *New York Times*, and other publications.

Further information: *How to Raise and Train Pigeons*, William H. Allen, Sterling Publishing Co., New York, 1972.

Pigeon Racing, Herbert R. Axelrod and E.C. Welty, Sterling, New York, 1973.

(All I Need Is) The Heir That I Breed. Elaine de Man wrote her master's thesis on the breeding behavior of Japanese quail. She never made a dime from a quail, and she was accused of voyeurism. Her last article for *Air & Space/Smithsonian* was "The Happy Landing" (April/May 1987).

The High-Flying Legacy of Eugen Sänger. Helmut Muller is a photographer, television director, and journalist specializing in science and aerospace in the United States and Europe. He thanks Hartmut Egon Sänger for invaluable assistance with this article.

Further information: *Space Flight: Countdown for the Future*, Eugen Sänger, translated and edited by Karl Frucht, McGraw-Hill, New York, 1978.

Rockets, Missiles, and Space Travel, Willy Ley, Viking, New York, 1959.

Slow Dancing. Fred Reed writes a syndicated military column for Universal Press. His last article for *Air & Space/Smithsonian*, "All Quiet on the Launch Pad," appeared in the February/March 1987 issue.

Tilt! Edwards Park is a columnist for *Smithsonian*. During World War II he flew a P-39 he affectionately named Nanette. A monogamous airplane, it tried to kill any other pilot who flew it.

Three If By Air . . . Jake Page is co-author of *Energy, Vulnerability, and War* (W.W. Norton and Co., New York, 1980) and is a frequent contributor to *Air & Space/Smithsonian*.

In the Wings . . .

It's Caapp-tain Midnight!—From 1939 to 1958, this dashing pilot overcame the forces of evil on radio shows, on television programs, in comic strips, and in the movies. He was the ideal airborne idol for a time when men were men and good guys were really good. →

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Eddie Brandt's Saturday Matinee

Mediasat—How does the First Amendment apply to information gathered from space? ABC News editor Mark Brender wants to know, because he'd like to see news organizations launch and use their own satellites.

China Builds a “Douglas”—East is East and West is West, but now, thanks to a co-production agreement between McDonnell Douglas and the Shanghai Aviation Industrial Corporation, the twain have met on the shop floor.

Adrian Bradshaw/Visions

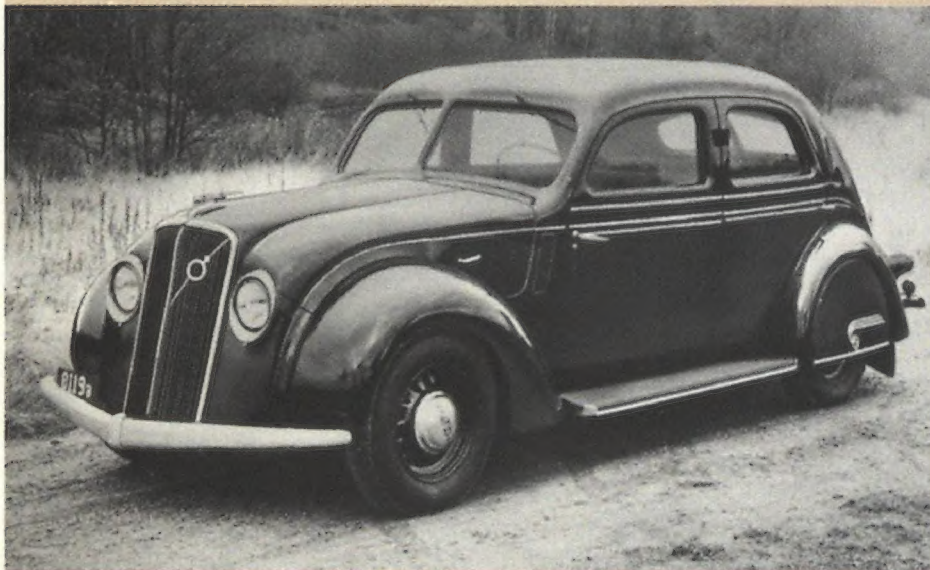
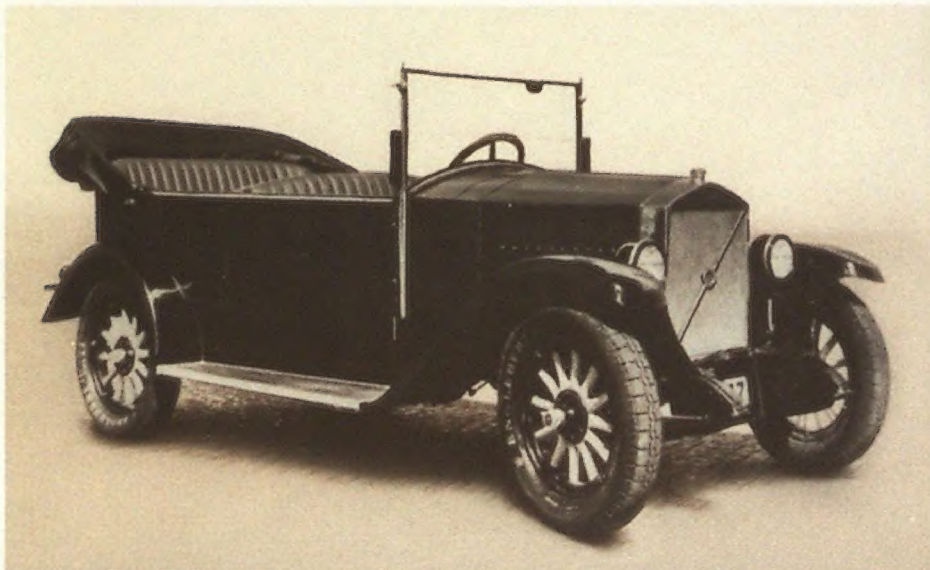


James Sugar/Black Star



Space Heroes of the Soviet Union—Yuri Gagarin (far left) is first among the pantheon of space travelers revered by the Soviet citizenry. In museums, monuments, murals, and shrines throughout the country, Soviets pay homage to the men, women, and machines of the Space Age. Even visitors can get a taste of space worship: Moscow's Kosmos Hotel overlooks the Cosmonaut Memorial, which features a rocket-topped spire and a base adorned with inspirational friezes.

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